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### A REVISION OF THE OLD WORLD SPECIES OF CALOPHYLLUM (GUTTIFERAE)\*

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75. *Calophyllum confertum* P. F. Stevens, sp. nov.

FIGURE 26, f, g.

A speciebus aliis Calophylli Malesianae quibus internodia terminali innovationis brevior aliis habent in ramulo in siccitate minute reticulato, pagina superiore laminae in siccitate brunnea pagina inferiore pallidior et venulis lateralibus 3 usque ad 6 per 5 mm. (in speciebus aliis 5 usque ad 19 per 5 mm.), differt.

Tree ca. 36 meters tall; trunk and bark not known.

Twigs slightly flattened, 1.8–2.2 mm. across, 4-angled, drying brown to yellowish, surface minutely reticulate, glabrous; axillary innovations lacking basal scars; internodes mostly 1–3 cm. long; uppermost internode of innovation up to 7 mm. long; uppermost pair of axillary buds rounded, less than 0.5 mm. long, inconspicuous; terminal bud plump to narrowly conical, 1.3–2.5 mm. long, with adpressed, brown indumentum (hairs, FIGURE 22, m), underdeveloped internode absent. Petiole 0.4–1 cm. long, deeply concave above and convex below, glabrous; lamina obovate, (3.2–)5–8.5(–18) by (1.1–)2.3–4(–7.1) cm., rounded to subacute at apex, narrowly cuneate at base, slightly undulate and somewhat recurved at margin, coriaceous, drying cinnamon above and sepia below, glabrous at maturity, the midrib above subabruptly narrowed near base, slightly depressed at first, becoming subelevated, inconspicuous, 0.15–.3 mm. wide at midpoint, below raised, somewhat striate, the venation subapparent above and subobscure below, slightly raised, 3 to 6 veins/5 mm., angle of divergence 40–50°. Inflorescences from foliate axils near ends of twigs, with scars of 5 to 7 flowers, unbranched, the axis 3–5 cm. long, glabrous, lowest internode 3.3–3.7 cm. long; bracts not known; pedicels 0.7–2 cm. by ca. 1.8 mm., glabrous. Flower not known. Fruit spherical, 1.5–1.8 cm. long and across, rounded at apex, drying with shallow and rounded wrinkles, sharply wrinkled when young, pale brown; outer layer detaching cleanly from stone, 1.7–2 mm. thick, compact; stone spherical,

\*Continued from Volume 61, page 424.

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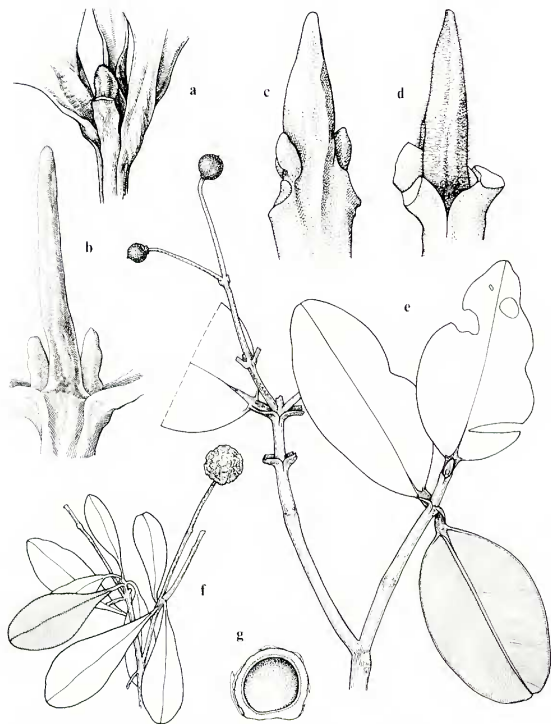


FIGURE 26. a, *Calophyllum praetermissum* (Haviland & Hose 3342), terminal bud,  $\times 3$ . b, *C. aerarium* (Cel./II-354), terminal bud,  $\times 3$ . c, *C. andersonii* (Haviland = 1812), terminal bud,  $\times 6$ . d, e, *C. teysmannii* var. *bursiculum* (S 17230): d, terminal bud,  $\times 4$ ; e, habit,  $\times 0.5$ . f, g, *C. confertum* (SAN 17146): f, habit,  $\times 0.5$ ; g, fruit, transverse section,  $\times 1$ .



ca. 1.2 cm. long and across, rounded at apex, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer (?) thin.

TYPE: Brunei, Temburong, summit of Bukit Patoi, 255 m., 5 April 1957, *SAN 17146* coll. *Smythies, Wood, & Ashton* (holotype, A; isotypes, BO, K, KEP, L, SAN (several), SING).

DISTRIBUTION. Northeastern Sarawak, Brunei (MAP 24).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 3rd Division: Ulu Arip, Balingian, *Ashton 6002* (A). 4th Division: Nyabau Catchment area, *Ashton 6001* (A). BRUNEI: Andalau F.R., 60 m., *Ashton s.n.*, July 1959 (SAR); Bukit Biang, *Ashton s.n.*, July 1959 (SAR). Sine loco: *Brunig Li 50* (SAR).

ECOLOGY. Forest, 60–255 m. alt.

Specimens of *Calophyllum confertum* can readily be recognized, even when sterile, by the minutely reticulate twigs, leaves aggregated at the ends of the twigs, and obovate leaf blades with distant, steeply ascending venation. The epithet *confertum* means “crowded,” an allusion to the congestion of the leaves at the end of each innovation.

*Calophyllum obliquinervium* also has innovations with short terminal internodes, but its leaf has denser venation, and the midrib on the lower surface of the blade is less prominent than in *C. confertum* and often does not reach the apex. It differs further in having terminal inflorescences, and fruits with the outer layer less than 0.5 mm. thick and not compact. *Calophyllum confertum* appears to be most closely related to the imperfectly known *C. praetermissum*; for the differences between the two, see the latter.

All specimens of *Calophyllum confertum* except the type are sterile. However, the other specimens have the characteristic reticulation of the twig (except sometimes in young growth), the short terminal internode, and the distant venation of the type specimen. Although the leaf blades are somewhat larger than those of the type (measurements in parentheses above), the specimens may have been taken from young trees.

76. *Calophyllum praetermissum* P. F. Stevens, sp. nov.

FIGURE 26, a.

A speciebus aliis *Calophylli* in foliis apicibus innovationibus quaternis aggregatis, ramulis in siccitate griseo-brunneis vel albescentibus, lamina mediocra margine haud undulata, et inflorescentia axillaris internodio basali 2–7 cm. longo, differt.

Tree 10–17 meters tall, d.b.h. to 35 cm.; trunk without spurs or buttresses; outer bark dark to pale brown, tending to have shallow cracks, scaly; inner bark pink; latex opaque, sparse, barely sticky (*S 2761*).

Twigs slightly flattened, 1.2–2.3 mm. across, transiently to rather persistently 4- or 6-angled, drying gray-brown to whitish, glabrous or sparsely short-tomentose; axillary innovations lacking basal scars; basal internodes of innovation to 5.5 cm. long, intermediate internodes 0.7–2.5 cm. long, terminal internodes 0.1–1 cm. long; uppermost pair of axillary buds inconspicuous, less than

0.5 mm. long; terminal bud conical, 2–3 mm. long, with short, tomentose, brown indumentum (hairs, FIGURE 22, n–p), underdeveloped internode absent. Petiole 4–7 mm. long, broadly concave above, convex below, drying blackish, when young with few hairs on edges; lamina obovate, 3.2–7.4(–12) by 1.5–3.6(–4) cm., rounded to retuse at apex, acute to cuneate at base, not undulate and slightly to clearly and narrowly recurved at margin, coriaceous, drying dark brick above and sepia below, glabrous, the midrib above rather abruptly narrowed at base, somewhat depressed at first, becoming slightly raised, 0.1–0.2 mm. wide at midpoint, below slightly raised, striate, the venation on both surfaces  $\pm$  apparent, raised, 5 to 9 veins/5 mm., angle of divergence 50–65°. Inflorescences from uppermost foliate axils, with 5 to 9 flowers, unbranched, sometimes flabellate, the axis 4.5–9.5 cm. long, glabrous or very sparsely puberulent toward base when young, lowest internode 2–7 cm. long; bracts ovate, ca. 1 mm. long, subtomentose below, not persistent; pedicels 1–2.2 cm. long, glabrous. Flower known only from bud, (?)hermaphroditic; tepals 4, the outer pair broadly ovate to orbicular, ca. 5 by 4.5 mm.; stamens 80 to 110, the anthers oblong, 1.5–2.2 mm. long, slightly retuse at apex; ovary ca. 1.5 mm. long, glabrous, the style ca. 3 mm. long, the stigma peltate, ca. 0.6 mm. across. Immature fruit subspherical, ca. 8 by 7 mm., drying finely wrinkled, brown; outer layer ca. 1.3 mm. thick.

TYPE: Sarawak, near Kuching, 24 Nov. 1894, *Haviland & Hose* 3342 (holotype, BM; isotype, K).

DISTRIBUTION. Northwestern Borneo (MAP 24).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 1st Division: near Kuching, *Bartlett s.n.*, anno 1893 (BM); Selang F.R., *S 7360* (?) (SAR). 3rd Division: Batang Igan, Sungei Tutus logging camp, *S 30526* (SAR); Loba Kabang South Protected Forest, *S 2761* (SAR). **KALIMANTAN.** Selatan: Amoentai, Rantau Kodjang, 10 m., *bb 7787* (BO). Barat: Palo, 5 m., *Becking 41* (BO).

ECOLOGY. Swamp forest, low. alt. Late bud in November.

*Calophyllum praetermissum* differs most obviously from *C. confertum* in its twigs, which do not dry finely reticulate, and in its leaf blades, which have denser venation and dry darker on the upper surface than on the lower. Although the two taxa have a similar distinctive inflorescence type and leaf arrangement, they have different hairs and ecology. The epithet *praetermissum* ("overlooked") refers to the superficial similarity of this species and *C. confertum*.

At first sight sterile specimens of *Calophyllum praetermissum* are somewhat like those of *C. andersonii*. However, in the latter species only the older twigs dry a pale gray-brown color, so there is less contrast between dark petiole and light twigs; the lamina is concave toward the base rather than broadly convex as in *C. praetermissum*. Neither the inflorescence nor the leaf arrangement of *C. andersonii* is like that of *C. praetermissum*.

*S 7360* is a fragmentary specimen and is included here with hesitation.

77. *Calophyllum andersonii* P. F. Stevens, sp. nov.

FIGURE 26, c.

*C. fragrans* Ridley, Kew Bull. 1938: 120. 1938, *typo excepto*; J. Anderson, Gard. Bull. Singapore 20: 154. 1963, Trees Peat Swamp Forest Sarawak, 85, pl. 27A. 1972.

A speciebus aliis *Calophylli* in gemma terminalis corpulenta, lamina mediocra obovata apice plus minusve retusa venulis lateralibus subdistantibus validisque, tepalis 4, et fructu ovoideo usque ad 1.6 cm. longo apice acuto strato exteriori circa 1.5 mm. crasso et putamine parietibus circa 0.8 mm. crassis, differt.

Tree 15–23(–30) meters tall, d.b.h. to 20 cm.; trunk with buttresses to 0.9 meters tall, or stilt roots to 1.2 meters tall; outer bark dark brown to pale yellowish gray, narrowly fissured, the inner surface dull orange-brown; under bark dull orange-brown; inner bark reddish to dark brown; latex sparse, whitish, (?) sticky or not.

Twigs slightly flattened, 1.3–3 mm. across, rounded, striate when old, drying brown when young, when older grayish to yellow-brown, glabrous or brown-farinoso when young; axillary innovations lacking basal scars; internodes 0.5–4(–5.5) cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long, erect; terminal bud plump (narrowly conical), 3–6 mm. long, with gray-brown, subcrustaceous to puberulent indumentum (hairs, FIGURE 22, e, f; some also moruloid), underdeveloped internode to 2.5 mm. long. Petiole 0.7–2.1 cm. long, broadly concave above and convex below, glabrous, drying blackish; lamina obovate, 2.6–10(–13) by 1.8–5.5(–6.7) cm., retuse to rounded (rarely cuneate) at apex, acute to cuneate at base, slightly and distantly undulate and somewhat recurved at margin (with submarginal vein 0.4 mm. from margin, or vein obscured by thickening), coriaceous, drying sabelline to greenish olivaceous above and sepia to fulvous below, when young farinose-puberulent on midrib below, the midrib above narrowing gradually from base, subdepressed at first, becoming raised, 0.1–0.2 mm. wide at midpoint, below raised, rounded to subangled, the venation subobscure to apparent above and apparent below, raised, 4 to 9 (to 12) veins/5 mm., angle of divergence 45–70°. Inflorescences from foliate axils along twigs, with 7 to 11 flowers, unbranched, the axis 1.3–2.7 cm. long, puberulent at least near base, lowest internode 2–9 mm. long; bracts elliptic, to 3 mm. long, deciduous; pedicels 0.5–1.3 cm. long, frequently farinose when young, slender. Flower (?) hermaphroditic; tepals 4, the outer pair broadly ovate, 3.5–4.5 by ca. 4 mm., the inner pair broadly obovate, ca. 6 by 4.3 mm.; stamens 70 to 85, the filaments to 2.5 mm. long, the anthers oblong, 0.8–1.2 mm. long, ± retuse at apex; ovary ca. 1.3 mm. long, the style ca. 1.5 mm. long, the stigma subpeltate, 0.55–0.7 mm. across, not clearly radiate. Fruit ovoid, 1.4–1.6 by ca. 1 cm., acute at apex, drying vinaceous-brown, closely and rather shallowly wrinkled; outer layer detaching cleanly from stone, 1.2–1.8 mm. thick, compact; stone ellipsoid, 8.5–10 by 6.5–7 mm., acute to obtuse at apex, the walls 0.7–0.8 mm. thick, smooth, unmarked; spongy layer (?) thin.

TYPE: Sarawak, 3rd Division, Sibul [Loba Kabang South Protected Forest],

20 Feb. 1954, *S* 480 coll. *Ahmady* (holotype, SAR; probable isotypes "coll. *Anderson*," KEP, SAR, SING).

DISTRIBUTION. Northwestern Borneo (MAP 33).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 1st Division: ca. 3 km. from Kuching, *Haviland* 1812 (BM, L, SAR, SING), = 1812 (BM, BO, GH, L); Stapok F.R., *S* 24679 (A, L, SAR, SING), 30590 (SAR); (?)G. Pueh F.R., *S* 7523 (SAR); Sabal Tapang, 150 m., *Stevens et al.* 178 (A). 3rd Division: Rantau Panjang, *S* 2739 (SAR); Loba Kabang South Protected Forest, *S* 2698 (SAR); Sungei Tutus logging camp, *S* 30543 (SAR). BRUNEI: H. Simpai Berakas, *S* 2003 (SAR). KALIMANTAN. Barat: Palo, 5 m., *Becking* 76 (BO).

ECOLOGY. Usually in peat swamp (alan forest dominated by *Shorea albida* Symington), also in mixed dipterocarp forest on low hills at Sabal Tapang; 5–150 m. alt. Flowering August, September, and December (flower scented); submature fruit in February.

*Calophyllum andersonii* can be recognized by its short, plump terminal buds, its twigs, which dry a grayish- or yellowish-brown when older, and its obovate leaf blades with retuse apices and relatively distant venation. The flowers have four tepals, and the small fruits have a well-developed outer layer and stone walls about 0.8 mm. thick. The epithet commemorates J. A. R. Anderson, well known for his work on the peat swamps of northwestern Borneo where this species usually grows.

*Calophyllum andersonii* is somewhat like *C. teysmannii* var. *inophylloide*; the latter has similar bark, but the latex is yellow. However, living leaves of *C. andersonii* are notably less rigid than those of *C. teysmannii* var. *inophylloide*, the midrib is not raised (seen also in the dried leaf), and the older twigs dry striate and pale yellowish brown, in contrast to the blackish petioles. *Calophyllum teysmannii* var. *inophylloide* also has larger fruits that are rounded at the apex and have a relatively much thinner stony layer. The filaments of *C. andersonii* appear to be papillate toward the apex, a character that has not been noticed in *C. teysmannii*, but more material is needed to confirm this difference.

The paratype of *Calophyllum fragrans*, *Haviland* 1812, is to be referred to *C. andersonii*. However, the two species are not at all close, *C. fragrans* (= *C. hosei*) having, for example, axillary innovations with basal scars, leaf blades with much denser venation, and ellipsoid fruits.

*S* 5935 (Brunei, Andalau F.R., 45 m.) may be a specimen of *Calophyllum andersonii*, but it has leaf blades with very broadly recurved margins and a terminal bud 6.5–9 mm. long on an underdeveloped internode 0.4–1.5 cm. long. There are two types of fruit associated with the specimen, although neither has been seen attached to a shoot. One is somewhat similar to that of *C. andersonii*, although a little larger (to 1.8 by 1.4 cm.) and more deeply wrinkled. The other is spherical, ca. 2 cm. long, and has an outer layer about 0.5 mm. thick; it is perhaps similar to that of *C. alboramulum* (see that species; *KEP* 80089 is also similar to *S* 5935).

78. *Calophyllum teysmannii* Miq. Fl. Indiae Batavae Suppl. 1(3): 499. Dec. 1861. TYPE: Sumatra, prope Paja-kombo, *Teymann*, HB 650 (holotype, u; isotypes, BO, L, P).

Tree 3–40 meters tall, d.b.h. to 95 cm.; trunk very often but not always with spurs or small buttresses to 70 cm. tall; outer bark brown to gray-brown, fissured and scaling, not hoop marked, the inner surface dirty orange-brown to blackish; under bark dark orange-brown to deep red; inner bark red; latex yellow, clear to opaque, sticky to fluid; sapwood pink to yellow; heartwood hard.

Twigs slightly to definitely flattened, (1–)1.5–3.5(–5) mm. across, not or 2-, 4-, or 6-angled, often with transverse lines at nodes, drying brown to blackish, transiently puberulent to subpersistently tomentose; axillary innovations lacking basal scars; internodes 0.5–3(–5) cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long, erect to spreading; terminal bud plump to conical, (2–)3.5–9.5(–12.5) mm. long, with subcrustose grayish to tomentose, erect to adpressed, brown indumentum (hairs, FIGURES 25, 1–o; 27, c–i; some also moruloid), underdeveloped internode to 5 mm. long. Petiole 0.35–2.2(–3.5) cm. long, broadly and shallowly concave above, convex below, sometimes subpersistently tomentose; lamina obovate (elliptic, oblong, cuneiform, subovate, or suborbicular), (2–)3.3–13.8 by (1.3–)2.1–6.6 cm., retuse (rounded or acute) at apex, acute to cuneate (rarely rounded) at base, flat to slightly undulate and sharply recurved at margin, marginal thickening absent to 1.2 mm. wide, coriaceous to very coriaceous, drying bay to umber (pale khaki) above and umber (fulvous) below, usually  $\pm$  transiently puberulent on midrib on both surfaces, or subpersistently tomentose—also on margin when young, the midrib above often narrowing  $\pm$  abruptly near or gradually from base, raised (adjacent blade obscurely raised) ( $\pm$  depressed), 0.1–0.8 mm. wide at midpoint, below strongly raised, striate to angled, the venation above subobscure to apparent, below  $\pm$  apparent, raised, (4 to) 6 to 12 (to 21) veins/5 mm., angle of divergence 50–80°. Inflorescences from foliate axils near apex and along twigs, with 3 to 11 flowers, unbranched (rarely 3-flowered branches to 1.2 cm. long, and/or flabellate), the axis (0.5–)1.3–6 cm. long, puberulent (tomentose) especially toward base, lowest internode (0.1–)0.5–3.4 cm. long; bracts unknown; pedicels 0.5–3.5(–4.3) cm. long, glabrous (rarely puberulent). Flower (?)hermaphroditic; tepals 4 to 8, the outer pair ovate to suborbicular, (4–)5.5–7.5 by (3.5–)5–6(–6.5) mm., strongly concave, the next pair broadly elliptic, 5.5–10 by 4–7 mm. (rarely 7 by 6 mm.), the inner ones, if any, obovate to lingulate, 6.5–10 by 4–6.5 mm. (rarely 10 by 3 mm.); stamens 65 to 145, the filaments to 4.5 mm. long, the anthers oblong, 1.2–2 mm. long, slightly retuse to truncate at apex; ovary 1–2 mm. long, the style 2–3 mm. long, the stigma peltate, 0.5–1.2 mm. across, 2- or 3-radiate. Fruit spherical to ellipsoid, 1.7–3.7 by 1.4–3.2 cm., rounded (rarely pointed) at apex, drying dark vinaceous-brown, faintly striate to smooth; outer layer rarely detaching cleanly from stone, (1–)1.5–3 mm. thick, compact and rather hard; stone spherical to ellipsoid, 1.4–3 by 1.1–2.6 cm., rounded at apex, the walls 0.1–0.4(–0.6) mm. thick, smooth, unmarked; spongy layer thin; cotyledons of dried embryo separating easily.

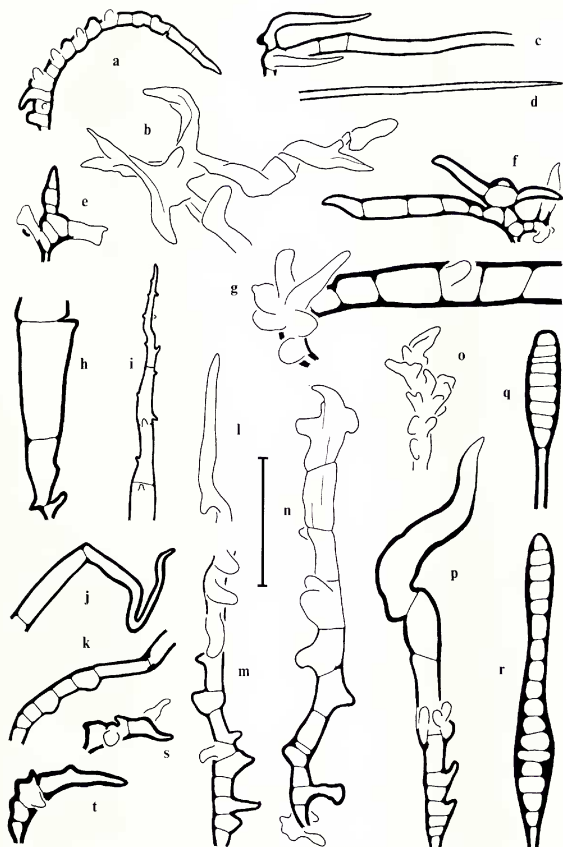
Key to the Varieties of *Calophyllum teysmannii*

1. Terminal bud usually  $\pm$  conical, initially enclosed by petiole bases of uppermost pair of leaves; stem often with horizontal lines at node; lamina drying  $\pm$  flat; inflorescences borne in upper leaf axils; pedicels (0.5–) 1–3.5(–4.3) cm. long.
  2. Twig with prominent, V-shaped lines at node. . . . . 78b. var. *bursiculum*.
  2. Twig with at most obscure horizontal lines at node. . . . . 78a. var. *teysmannii*.
1. Terminal bud often plump, rarely enclosed by petiole bases of uppermost pair of leaves; stem practically never with horizontal lines at nodes; lamina often drying concave; inflorescences often borne in leaf axils along stem; pedicels 0.5–1.8(–3.5) cm. long. . . . . 78c. var. *inophylloide*.

78a. *Calophyllum teysmannii* Miq. var. *teysmannii*

- C. teysmannii* Miq.; F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868; H. Keng, Gard. Bull. Singapore 28: 245. 1975; *C. miquelii* Vesque in C. DC. Monogr. Phanerog. 8: 607. 1893, *nomen novum* for *C. teysmannii* Miq.
- C. intramarginale* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 342. pl. 22. 1956. TYPE: Malaya, Trengganu, Gunong Padang, 4000 feet [1218 m.], June 1937, *SFN 31900* coll. *Moysey & Kiah* (holotype, SING; isotypes, A, K, KEP).
- C. inophylloide* King var. *singaporense* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 316. pl. 9. 1956; Kochummen, Malayan Forest Rec. ed. 2. 17: 215. 1965; Smythies, Common Sarawak Trees, 61. 1965, excl. spec. cit.; T. C. Whitmore, Gard. Bull. Singapore 26: 270. 1973, Tree Fl. Malaya 2: 186. 1973; Corner, Gard. Bull. Singapore Suppl. 1: 104. 1978. TYPE: Singapore, MacRitchie Reservoir, 10 Nov. 1936, *SFN 32518* coll. *Corner* (holotype, SING; isotypes, K, KEP).
- C. inophylloide* auct., non King; Ridley, Jour. Straits Branch Roy. Asiatic Soc. 34: 47. 1900, Fl. Malay Penin. 1: 186. 1922, *pro parte*.
- C. rhizophorum* auct., non Teijsm. & Binn.; Meijer, Bot. Bull. Forest Dept. Sabah 7: 15. 1967.

FIGURE 27. Hairs (from terminal bud, unless otherwise noted). a, *Calophyllum enervosum* (KEP 71894), from abaxial surface of bract, most hairs completely unthickened. b, *C. pyriforme* (SAN 75654). c–i, *C. teysmannii*. c–f, var. *teysmannii*: c, d, *S 11249*, apex and base of hair ca. 1200  $\mu$ m. long; e, f, *FRI 12644*. g, var. *bursiculum* (*S 17230*), base of moderately birefringent hair ca. 1300  $\mu$ m. long. h, i, var. *inophylloide*: h, *S 16397*, base of slightly birefringent hair ca. 390  $\mu$ m. long; i, *bb 27611*, apex of hair ca. 1000  $\mu$ m. long. j–p, *C. ferrugineum*, expanded apical cells strongly birefringent. j–m, var. *ferrugineum*: j, k, *KEP 105163*, apex and base of hair ca. 720  $\mu$ m. long; l, m, *SFN 28196*, apex and base of hair ca. 660  $\mu$ m. long. n, var. *oblongifolium* (*FRI 2594*). o, p, var. *orientale* (*BRUN 5697*), hairs to 1450  $\mu$ m. long; o, from stem. q, r, *C. macrocarpum* (*S 15898*), rare hair type from inside bud. s, t, *C. aerarium* (*Cel./II-354*). Scale = 120  $\mu$ m. (in c, d, scale = 240  $\mu$ m.).



*C. ?cymosum* auct., non Miq.; Koord.-Schum. Syst. Verzeich. 2: 39. 1910, *quoad* Koorders 10336.

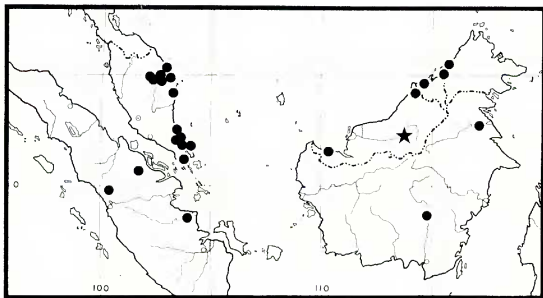
*Calophyllum* sp. 44 M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 350, pl. 30. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 173. 1973; Corner, Gard. Bull. Singapore Suppl. 1: 105. 1978.

Tree 3–36 meters tall; sometimes with loop roots; latex from cut bark yellow, fluid, clear, becoming opaque when rubbed.

Twigs (1–)1.5–2.5 mm. across, with obscure raised lines at nodes; terminal bud conical or  $\pm$  plump, (2–)3–8 mm. long, with sericeous to tomentose indumentum. Lamina usually obovate (rarely cuneiform, suboblong, suborbicular, or subovate), (2.6–)3.4–9 by (1.3–)2.1–4.6 cm., slightly recurved at margin, marginal thickening 0.4–0.8(–1.2) mm. wide, drying  $\pm$  flat, the midrib flat to raised, 0.15–0.3(–0.4) mm. wide at midpoint. Inflorescences from upper foliate axils, sometimes two together, lowest internode (0.7–)1.5–3.4 cm. long; pedicels (0.5–)1–3.5 cm. long.

DISTRIBUTION. Northeastern and southeastern Malay Peninsula to Borneo (MAP 25).

SELECTED SPECIMENS SEEN. **Malaya.** KELANTAN: G. Rabong, 671 m., *FRI* 20622 (KEP); Sungei Perias near K. May, 305 m., *FRI* 4114 (K, KEP). TRENGGANU: along Sungei Pelong, *FRI* 14854 (K, KEP, SING); Ulu Brang, near K. Lallang, 305 m., *FRI* 12593 (K, KEP, SING); G. Padang, 1219 m., *FRI* 12644 (A, KEP, SAN, SING); Ulu Sungei Loh, 716 m., *FRI* 10840 (A, K, KEP, SING); Kuala Trengganu–Sengau, *KEP* 81266 (KEP); Jerengau State Land, *KEP* 79853 (KEP); Bukit Bauk F.R., 120 m., *KEP* 77980 (KEP); Dungun, Bukit Besi, *KEP* 66957 (KEP); Rasau Kerli F.R., 310 m., *KEP* 67753 (A, BO, K, KEP, SING); Kemaman, Bukit Kajang, Ulu Bendong, 150 m., *Corner s.n.*, 3 Nov. 1935 (?) (SING). PAHANG: G. Tahan, *Wong & Wyatt-Smith* 168 (KEP); Taman Negara near



MAP 25. Distribution of *Calophyllum teysmannii* var. *teysmannii* (circles) and *C. teysmannii* var. *bursiculatum* (star) in Malasia.



Kuala Tahan, 210 m., *FRI 20136* (KEP). JOHORE: G. Arong F.R., 30 m., *KEP 54250* (BO, K, KEP, SING); Kluang F.R., 305 m., *KEP 98026* (K, KEP, SING); Jemaluang F.R., *KEP 73551* (KEP); G. Blumut, 518 m., *FRI 8839* (KEP); G. Panti E., 305–457 m., *Shah & Ahmad 2917* (A, KEP, LAE, SING, UC); Kota Tinggi, Panti F.R., 210 m., *KEP 70184* (KEP, SING); Kg. Hubong, Endau, *Kadim & Noor 321* (K, L, SING); Jason Bay, Sungei Semadan, *Corner s.n.*, 30 April and 16 June 1934 (KEP, SING); Tanjong Jurat, *Lake & Kelsall s.n.*, anno 1892 (SING); Mawai, *Corner s.n.*, 21 May 1934 (SING). **Singapore:** Seletar Reservoir, Mandai Road, *Shah & Shukor 2398* (A, C, SING); Botanic Gardens, *SFN 28662* (A, BO, K, KEP, LAE, SING); MacRitchie Reservoir, *SFN 32518* (KEP); Stag Mount, *Ridley s.n.*, anno 1909 (K); Bukit Timah, *Baker 5339* (G, KEP, NSW). **Sumatra.** RIAU: Siak-Tanggana, *Koorders 10336* (?) (BO). DJAMBI: Djambi, Simpang, 45 m., *bb 13162* (BO). BARAT: Taram, E. of Pajakumbuh, 500–1000 m., *Meijer 6914* (L). **Borneo.** SARAWAK. 1st Division: Kuching, Stapok Road, *Brooke 9413* (G, L). 4th Division: Baram, Marudi F.R., *S 8289* (K, L, SAN, SAR). BRUNEI: Bukit Puau, 24 m., *Ashton s.n.*, Aug. 1958 (SAR). SABAH. Beaufort: Lumut, on railway line, mile 2½, *SAN 58410* (L, SAN). Papar: Kimanis F.R., 6 m., *KEP 80288* (KEP); Bongawan F.R., *A 397* (A, K, KEP, L, SING). KALIMANTAN. Timur: Boelongan, Binai, *Rutten 17* (U). Tengah: Bonjoet, bij Boentok, *Obi 1880* (= *bb 578*) (BO, L).

**ECOLOGY.** Peat swamps, "secondary forest on mangroves" (*SAN 58410*), flat-lying mixed dipterocarp forest, kerangas vegetation, and ridges in lower montane rain forest; to 1220 m. alt. Flowing February, June to August, November, and December (flower scented); fruiting March to May, and July (inside of fruit magenta—*FRI 8839*). Lotong (wolverines) eat fruit (*Corner s.n.*, 8 Feb. 1935).

Bilabiate, purselike galls (FIGURE 5, h) occur on plants of this taxon throughout its range (e.g., Malaya, *Shah & Shukor 2398*; Sumatra, *Meijer 7037*; Sarawak, *Brooke 9413*). These galls seem to be most common on young plants. Caused by a coccid (Lecanodiaspididae – *Amorphococcus* sp.), they develop abaxially on the midrib and shorten the internodes (Anthony, 1974). Anthony also reports psyllid galls that may affect each half of the leaf separately, thus causing it to become revolute. Elongate, slitlike galls on the lower and sometimes also on the upper surface of the lamina, generally found along the midrib or near the margin, are also known (e.g., *KEP 66957*, Malaya; *SFN 32518*, Singapore). *Teysmann, HB 650*, from Sumatra, has a row of raised, pustular swellings on either side of the midrib on the upper surface of the lamina.

**GERMINATION AND YOUNG PLANT.** The radicle breaks the stone wall ca. 5 mm. to one side of the base. The seedling usually has two pairs of leaves separated by an internode less than 8 mm. long. (Some seedlings apparently have up to four pairs of leaves separated by internodes of ca. 1 cm. or more; the lowest two pairs of leaves drop off (*Stevens et al. 108*)). Subsequent growth is erect, the terminal bud is functional, and the internodes produced are well developed (more than 1 cm. long). In the young plant at least the terminal bud has tomentose indumentum. Leaves produced by young plants are oval-elliptic, less than 12 cm. long, and usually rounded (to subacute) at the apex. (*KEP 77881, 99236*; *Stevens et al. 108*.)

78b. *Calophyllum teysmannii* Miq. var. *bursiculum* P. F. Stevens, var. nov.

FIGURE 26, d, e.

A varietatibus aliis *Calophylli teysmannii* in ramulis teretibus ad nodos lineis elevatis V-formatis basibus foliorum confluentibus ornatis et lamina elliptica mediocri plana percussa, differt.

Tree 15–21 meters tall; latex unknown.

Twigs 3.5–4 mm. across, with prominent, V-shaped lines at nodes, otherwise terete; terminal bud conical, 6–9 mm. long, sericeous. Lamina elliptic to suboblong (rarely suborbicular), 7.2–10.3 by 3.6–5.4 cm. (rarely ca. 4.2 by 4 cm.), slightly recurved at margin, marginal thickening not obvious, drying flat, the midrib slightly depressed, 0.15–0.55 mm. wide at midpoint. Inflorescences from upper foliate axils, lowest internode 2–2.5 cm. long; pedicels in young fruit 2.4–4.3 cm. long.

TYPE: Sarawak, 3rd Division, Hose Mountains, Mujong, Ulu Telamud, 310 m., 25 March 1964, *S 17230* coll. *Ashton* (holotype, K; isotypes, A, BO, L, SAN, SAR, SING).

DISTRIBUTION. Sarawak, known only from the 3rd Division (MAP 25).

ADDITIONAL SPECIMEN SEEN. **Borneo.** SARAWAK. 3rd Division: Tatai Memuas, Ulu Tiau, Mujong, Balleh, 180 m., *S 21225* (K, L, SAR, SING).

ECOLOGY. Heath forest on Kakus sandstone plateau, 180 m. alt. (*S 21225*); pole forest on dacite knoll, 310 m. alt. (*S 17230*).

Elongate, slitlike galls ca. 1 cm. long occur on the lower surface of the lamina (*S 17230*).

The name *bursiculum* ("little purse") alludes to the way in which the terminal bud is enclosed by the petiole and lamina bases.

78c. *Calophyllum teysmannii* Miq. var. *inophylloide* (King) P. F. Stevens, comb. nov.

*C. inophylloide* King, Jour. Asiatic Soc. Bengal, II. 59: 178. 1890; Vesque in C. DC. Monogr. Phanerog. 8: 549. 1893; Ridley, Fl. Malay Penin. 1: 186. 1922, *pro parte*; *C. inophylloide* King var. *inophylloide* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 315. 1956; Pukol & Ashton, Checklist Brunei Trees, 93. 1964; Kochummen, Malayan Forest Rec. ed. 2. 17: 213. 1965; T. C. Whitmore, Tree Fl. Malaya 2: 183. 1973. TYPE: Malaya, Perak, Batang Padang district, Aug. 1885, 300–500 feet [90–150 m.], *King's collector* [*Kunstler*] 8112 (isotypes, K, UC).

*C. marginatum* Wall. Catal. 4845. 1831; Choisy, Mém. Soc. Phys. Hist. Nat. Genève 12: 424. 1849; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 293. 1862; T. Anderson in Hooker f. Fl. Brit. India 1: 276. 1874; Vesque in C. DC. Monogr. Phanerog. 8: 608. 1893. *Nomen*.

*C. borneense* auct., non Vesque; Pukol & Ashton, Checklist Brunei Trees, 93. 1964, *pro parte*.

*C. fraseri* auct., non M. R. Henderson & Wyatt-Smith; T. C. Whitmore, Tree Fl. Malaya 2: 182. fig. 3. 1973, *pro parte*.

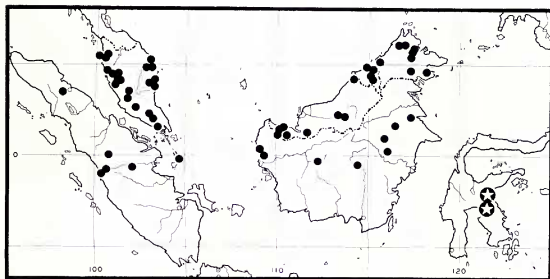
*C. cymosum* auct., non Miq.; Koord.-Schum. Syst. Verzeich. 2: 39. 1910, *quoad* Koorders 10335.

Tree 18–40 meters tall; latex from cut bark yellow, clear, sticky, rather fluid, becoming opaque when rubbed.

Twigs 2–5 mm. across, rarely with raised lines joining opposing leaf bases; terminal bud plump to conical, with grayish subcrustaceous to brown-tomentose indumentum. Lamina obovate to elliptic or oblong, (3.3–)5–13.8 by (2.2–)2.6–8 cm., somewhat recurved at margin to strongly so, marginal thickening to 0.2–0.8 mm. wide, tending to dry  $\pm$  boat shaped, the midrib depressed to  $\pm$  raised, 0.15–0.7 mm. wide at midpoint. Inflorescences usually from foliate axils along stem, lowest internode (0.1–)0.3–1(–2) cm. long; pedicels 0.5–1.8 (–3.5) cm. long.

DISTRIBUTION. Malay Peninsula to Borneo (MAP 26).

SELECTED SPECIMENS SEEN (letters refer to discussion in text). **Malaya.** KEDAH: Kedah Selatan Kulim, G. Inas, 305 m., *KEP 105249* (KEP). PINANG: Telok Pahang, *KEP 66369* (KEP); Pantai Acheh F.R., *KEP 27793* (KEP); Pulau Penang, *Curtis s.n.*, anno 1894 (SING). PERAK: near Tapah, *Ridley 3014* (K); Larut, *KEP 15* (KEP, SING); Keroh F.R. (near Gri), *KEP 31086* (KEP); Changkat Jong F.R., 30 m., *FRI 5873* (A, K, KEP); Taipeng, Selama, *KEP 273* (KEP); Parit, Kinta, *KEP 39464* (KEP); Bruas F.R., 60 m., *KEP 69406* (KEP); Chikus F.R., *KEP 3071* (KEP); Pondok Tandjong, *KEP 65558* (KEP); Batang Padang F.R., 15 m., *KEP 65053* (KEP, SING); Piah F.R., 853 m., *FRI 9051* (f) (KEP). SELANGOR: Bukit Lagong F.R., *KEP 13281* (KEP, SING); Ulu Gombak F.R., *KEP 24703* (KEP, SING), 768 m., *KEP 94716* (f) (A, K, KEP, SAN, SAR, SING); near Gap, 800–900 m., *Ando et al. 88* (f) (KEP); Kanching, *KEP 30106* (KEP). NEGRI SEMBILAN: Kuala Pilah, Serting, *KEP 62956* (KEP, SING). TRENGGANU: along Sungei Pelong, *FRI 14856* (K, KEP, SING); Dungun, Jerengau State Land, *KEP 81407* (KEP); Kemaman, Ulu Bendong, Bukit Kajang, *Corner s.n.*, 6 Nov.



MAP 26. Distribution of *Calophyllum teysmannii* var. *inophylloide* (circles) and *C. celebicum* (stars in solid circles) in Malaysia.

1935 (SING); Kuala Trengganu, proposed Belara F.R., 60 m., *KEP 76066* (KEP); Bukit Bauk F.R., 150 m., *KEP 104709* (KEP); 28th Mile Jalan Trengganu, 30 m., *KEP 78551* (KEP); Mandi Angin exped., S. watershed of Sungei Loh, 792 m., *FRI 12034* (f) (A, KEP, SING); Sungei Trengganu near Kuala Panchor, 610 m., *FRI 20561* (?f, *pro parte*) (KEP). G. Padang exped., Ulu Brang, 1006 m., *FRI 17776* (f) (A, KEP, SING). PAHANG: Sungei Kelui, G. Tapis, 518 m., *FRI 10052* (KEP); Pekan Road, Kuantan, *KEP 43102* (KEP); Ulu Kali, 914 m., *FRI 15643* (f) (KEP); Fraser's Hill, Bukit Jeriau, 1036 m., *FRI 20412* (f) (KEP, SING). JOHORE: Bukit Jelakoi, Kluang F.R., 225 m., *KEP 76290* (BO, K, KEP, SING, US); Labis F.R., *FRI 3843* (KEP); Ginting Simpah, 610 m., *KEP 71248* (KEP); G. Pulai F.R., 610 m., *FRI 9955* (KEP). **Sumatra and adjacent islands.** RIAU: Lingga, Sei. Soeling, *Ri/I-3* (BO); Indrag. Bovenlanden, Kwala Belilas, *Buwalda 6754* (BO, L); Beneden Langkat, Aloer Goetra, 50 m., *bb 16592* (A, BO). BARAT: bij Padang, 80 m., *Koorders 10335* (BO); Bangkinang, Katoer, 300 m., *bb 23395* (BO, L, MO); Sidjoendjoeng, Moearo, 150 m., *bb 9098* (BO). **Borneo.** SARAWAK. 1st Division: Semengoh F.R., Arboretum, 60 m., *S 32979* (K, SAN, SAR, SING); G. Matang, 305 m., *Stevens et al. 231* (A), *241* (c) (A); Sabal Tapang, 120 m., *Stevens*, sight record; G. Penrissen, 914 m., *S 16397* (c) (A, BO, K, L, SAN, SAR, SING). 2nd Division: Simanggang, Kampong Mentu, 305 m., *S 6527* (c) (K, L, SAR, SING). 3rd Division: Bukit Raya, Kapit, Pelagus, 270 m., *S 14359* (K, L, SAR, SING); Hose mts., Bukit Kajang Carapa, 900 m., *S 19090* (A, BO, L, SAR, SING). 4th Division: Miri, NE. Lambir Hills, Tukai formation, 120 m., *S 16756* (c) (K, L, SAR). BRUNEI: G. Pagon Periok, 1829 m., *BRUN 2442* (?) (SAR); Sagan Hill, 365 m., *S 18711* (c) (SAR); Temburong, Kuala Sekurop, 457 m., *BRUN 733* (BRI, K, L, SAR, SING); Kuala Belait, Andalau F.R., 60 m., *SAN 17476* (c) (A, BO, K, KEP, L, P, SING); Berakas F.R., 30 m., *S 2004* (c) (KEP, SAR, SING); Ulu Sugei, 60 m., *S 1013* (K, SAN, SAR, SING); Kuala Belalong, 610 m., *Ashton s.n.*, Nov. 1959 (SAR). SABAH. Beaufort: Beaufort Hill, 20 m., *SAN 44588* (K, L, SAN, SAR, SING). Ranau: Penibukan, 1524 m., *Clemens 40563* (prob.) (A, NY); Kinabalu, E. Rentis, Base Camp, Mesilau, 1829 m., *SAN 42189* (k) (A, SAN); Pinusok Plateau (Padang Golf), 2134-2438 m., *SAN 75844* (k) (SAN). Colombon Basin, 1524 m., *Clemens 40003* (k) (A, BO, L, NY, UC). Labuk & Sugut: Bukit Malawali, Labuk Road, *SAN 51770* (SAN); Mt. Meliau near Kiabau, 457 m., *SAN 51505* (c) (SAN); Bidu-Bidu hills above Kiabau, *SAN 43803* (c) (SAN); near Sungei Binuang, NW. of Sapi, 457 m., *SAN 44001* (?) (SAN); Bukit Tangkunan, Mile 86 Labuk Road, 425 m., *Stevens et al. 410* (?c) (A), 75 m., *Stevens et al. 414* (A). Kinabatangan: Lamag, Karamuak, E. of Sungei Meliau, 60 m., *SAN 53255* (c) (SAN), Bukit Tavai, 150 m., *SAN 53312* (SAN). Lahad Datu: Silam Mining Camp, 610 m., *SAN 37481* (SAN, SAR). Tawau: Brassey Range, 770 m., *Stevens et al. 475* (A). KALIMANTAN. Timur: Tidoengsche Landen, *bb 18240* (A, BO, L); Berouw, Telowek Daoen, Sungei Kasei, 75 m., *bb 12195* (BO); W. Kutei, Mt. Palimasan near Tabang on Belajan R., 190 m., *Kostermans 13144* (c) (BO, K, L, SING); 500 m., *Kostermans 12792* (c) (BO, L), 600 m., *Kostermans 12878* (BO, CANB, K, L, P), near Mt. Kemoel, 1200 m., *Endert 3458* (k) (BO, L); Long Bleh, Sei Pemetok, 50 m., *bb 29603* (BO, L). Tengah: Peeroek Tjahoe, Tahoedjan, 150 m., *bb 21166* (A, BO, L); Moeara Teweh, Pepas, 15 m., *bb 27766* (BO, L). Barat: Melawi Tjatit, B. Goentok, 180 m., *bb 27004* (BO, K, L, SING); Landak, Ngabang, 40 m., *bb 6402* (BO); Mempawa, Toho, 300 m., *bb 12388* (BO).

ECOLOGY. Usually well-drained lowland to colline mixed dipterocarp forest,

also in Trengganu (Malaya) in freshwater swamp, in Sarawak and Brunei in kerangas vegetation, in Kalimantan on (waterlogged) acid white sands, in Sabah on ultramafic rock; 4-1400(-2438?) m. alt. Flowering April, June to August, and September to November; fruiting December to February, April, August, and September (fruit greenish).

Bilabiate, purselike coccid galls are known from Malaya (e.g., *KEP* 15, *Stevens et al.* 30) and from Kalimantan (*Kostermans* 12840). Elongate, slitlike, pustular galls on the lower surface of the lamina are known from Sarawak (*Stevens et al.* 275, *FIGURE* 5, d).

GERMINATION AND SEEDLING. As for *Calophyllum teysmannii* var. *teysmannii*. The leaves of the young plant are often larger (up to 22 by 7.5 cm.) and are shortly, but markedly, acuminate at the apex. (*KEP* 62957, 76055, 79305; *FRI* 23084; *Stevens et al.* 30, 137, 231, 410.)

LOCAL USE. The wood is rather hard and is used in construction.

The epithet *inophylloide* ("like [the leaves of] *Calophyllum inophyllum*") was chosen because the leaves of the type of *C. inophylloide* are similar to those of *C. inophyllum*.

Although *Calophyllum teysmannii* is a variable taxon, it can generally be readily recognized by its moderate-sized, obovate (to oblong) leaf blades that are retuse at the apex and usually distinctly thickened at the margin. The axillary inflorescences are few flowered, and the flowers have four to eight tepals. The fruit is of moderate to large size and is more or less smooth when dry; the outer layer is thick ((1-)1.5-4 mm. across) and compact, and the stone walls are 0.1-0.4(-0.6) mm. thick. The hairs are usually branched at the base and are moderately birefringent under polarized light, or they may be almost moruloid but still obviously branched. The seedlings nearly always have two pairs of leaves separated by an internode less than 8 mm. long. Young plants of vars. *inophylloide* and *teysmannii* may have characteristic bilabiate, purselike, coccid galls, while adult plants of all three varieties are known to have slitlike galls. The outer bark is brown, fissured, and scaly; stilt roots or spurs occur frequently. The specific epithet commemorates the indefatigable collector, J. E. Teijsmann.

Specimens of saplings of *Calophyllum teysmannii* from Malaya have been confused with sterile specimens of *C. subhorizontale*. Although the two have similar terminal buds, the venation density of the leaves of *C. teysmannii* saplings is greater than that of *C. subhorizontale*, the twigs of the former do not dry the greenish color of the latter, and the thickened margin of the leaf common in *C. teysmannii* is not found in *C. subhorizontale*.

Some of the specimens of *Calophyllum teysmannii* with very coriaceous leaf blades may be confused with *C. sclerophyllum*. The two species have similar fruits, and *C. sclerophyllum* also has hard heartwood and well-developed stilt roots. In the low-lying forest of southern Johore, *C. sclerophyllum* and *C. teysmannii* var. *teysmannii* (the former described as *Calophyllum* sp. 44 by Henderson & Wyatt-Smith, *loc. cit.*) grow together, but they are quite distinct. In Sarawak both the local representative of *C. teysmannii* var.

*inophylloide* and its thick-leaved variant are quite distinct from the *C. sclerophyllum* there, although in this case there is no ecological overlap. *Calophyllum sclerophyllum* differs most obviously from *C. teysmannii* in having the lower surface of the lamina often punctate, the terminal bud never enclosed by the bases of the petioles, the seedling with but a single pair of leaves and with subsequently produced leaves alternate, and the young plant without purselike coccid galls.

#### Variation within *Calophyllum teysmannii*

The variation within *Calophyllum teysmannii* is mostly in terminal bud shape and indumentum; leaf size, texture, and indumentum; inflorescence position; pedicel length; and fruit size. There is a certain amount of variation in the young plant and also in bark characters. Even when dealing with the Malayan plants, Henderson and Wyatt-Smith had trouble deciding at which rank to recognize *C. inophylloide* var. *inophylloide* (= *C. teysmannii* var. *inophylloide*) and *C. inophylloide* var. *singaporense* (= *C. teysmannii* var. *teysmannii*). This problem has become exacerbated by the wider altitudinal, ecological, and geographic range of the species as here circumscribed. Much more collecting is still needed, especially from higher altitudes in both Malaya and Sabah, and also of the large, very coriaceous-leaved form that occurs throughout Borneo.

Although there are a number of differences between *Calophyllum teysmannii* var. *teysmannii* (and var. *bursiculum*) and *C. teysmannii* var. *inophylloide*, these differences intergrade. The conical terminal bud of *C. teysmannii* var. *teysmannii* is often enclosed by the upright petioles of the terminal pair of leaves, whereas the plump bud of var. *inophylloide* is not often so enclosed since the petioles are spreading. Young plants of *C. teysmannii* var. *inophylloide* have transverse lines across the stem at the nodes, and each innovation seems to consist of only a single pair of leaves. The former, and probably also the latter, are characteristic of adult plants of the other two varieties, but *C. teysmannii* var. *inophylloide* probably produces more pairs of leaves each innovation. In Malaya and Singapore, the latex of the two varieties differs: in *C. teysmannii* var. *teysmannii* it is clear and fluid, turning opaque when rubbed; in var. *inophylloide* it is clear but sticky. There are perhaps a few exceptions. The latex of KEP 76055 (Trengganu; var. *inophylloide*) was reported to be nonsticky; however, it was also slow to appear, while the nonsticky latex of var. *teysmannii* flowed freely. In Sarawak, on the other hand, the slash characters and, to a certain extent, the leaf characters (e.g., Stevens et al. 273, 275) of *C. teysmannii* var. *inophylloide* are those of var. *teysmannii* in Malaya; unfortunately, I did not see any trees of var. *teysmannii* in Sarawak.

It therefore seems most appropriate to reduce *Calophyllum inophylloide* to a variety of *C. teysmannii*. On Bukit Jelakoi, at the Kluang Forest Reserve, Johore, Malaya, the two varieties may grow quite near one another (KEP 76290, 225 m., var. *inophylloide*; KEP 76291, 210 m., var. *teysmannii*); this may also happen in northeastern Malaya.

*Calophyllum teysmannii* var. *bursiculum* is described because, although

it has the bud, hair type, and inflorescence characteristic of var. *teysmannii*, it can be readily distinguished by its very coriaceous, short-petioled leaves that lack obvious marginal thickening. Its distinctive twigs, with their V-shaped lines at the nodes, also distinguish var. *bursiculum* from both other varieties.

There is relatively little variation within *Calophyllum teysmannii* var. *teysmannii* as circumscribed. Specimens referable to *Calophyllum* sp. 44 (Henderson & Wyatt-Smith, *loc. cit.*) were seen in a swamp in southern Johore; in all characters of seedling and bark slash they were identical with *C. teysmannii* var. *teysmannii*. Some specimens tend to have a rather narrow lamina with a length : breadth ratio of 2-3 (that of fertile specimens of *C. teysmannii* var. *teysmannii* is usually less than 2). The fruit has an outer layer 1-1.3 (vs. more than 1.5) mm. thick. These are slight differences; *Calophyllum* sp. 44 is a local variant of var. *teysmannii* not distinct enough for formal recognition.

Two specimens from Trengganu (*FRI 12593, 14854*) have obovate to cuneiform leaf blades and ellipsoid fruits that are more or less pointed at the apex; the outer layer of the fruit is only ca. 1 mm. thick and detaches cleanly from the stone. The subtomentose indumentum on the twigs, midrib, and base of the inflorescence is better developed than is usual in adult plants of *Calophyllum teysmannii* var. *teysmannii*. Although these specimens are referred to this variety, the characters listed above suggest that they may be hybrids with *C. ferrugineum* var. *oblongifolium*, which grows in the same area.

Another specimen collected in the mountains of Trengganu, *FRI 12644*, looks similar to the form of *Calophyllum teysmannii* var. *inophylloide* growing on the same mountain (Gunong Padang, see below). However, it has the terminal bud and transversely lined nodes of var. *teysmannii*, and it is included in this taxon.

*Calophyllum teysmannii* var. *inophylloide* is a heterogeneous taxon as delimited here. Whitmore (1973, *loc. cit.*) included in his concept of *C. fraseri* specimens that seem to represent a local high-altitude form of *C. teysmannii* var. *inophylloide* ("f" in the list above). They sometimes have the stilt roots of the latter taxon, while *C. fraseri* lacks them. Stones and germinating seeds of *FRI 23084* (from Fraser's Hill) are identical to those of *C. teysmannii*, and hairs of specimens of this type, although very small, can perhaps be compared to the branched bases of the low-altitude form. These specimens have rather narrow, long-petiolate leaves with the blades lacking the obvious thickened margin of *C. teysmannii*. *FRI 19869* (Pahang, 792 m.) has bilabiate coccid galls. Specimens collected from The Gap (Selangor) seem to show a transition between this form and more typical *C. teysmannii* var. *inophylloide*, as suggested by the series of specimens collected by Ando *et al.* (88 (the form), 85, 151, 125 (close to var. *inophylloide*)).

There are a number of specimens from Borneo with large, very coriaceous leaf blades that are strongly recurved at the margin and that have a more or less depressed midrib ("c" in the above list). These robust specimens are at first sight very different from the rest of *Calophyllum teysmannii* var. *inophylloide*. However, specimens like *Kostermans 13144* have a more

or less raised midrib, while others such as *Kostermans* 12743 and *S* 1115 (the latter is in fruit) have lines across the stems at the nodes. Indumentum is quite variable: *Kostermans* 12743 and *Stevens et al.* 241 have short, tomentose indumentum on the bud, stem, midrib, and leaf margin; *SAN* 17476 and *Kostermans* 13144 have short, grayish, almost furfuraceous indumentum on the terminal bud and little obvious indumentum elsewhere. The shape of the terminal bud varies from conical to plump. It would be unwise to recognize these large, coriaceous-leaved specimens formally, but it should be emphasized that this variation is not understood. On Gunong Matang (Sarawak) two forms, ordinary var. *inophylloide* and a very coriaceous-leaved form with subtomentose indumentum, grow on the same ridge; on Mt. Palimasan (Kalimantan) two similar forms, as well as a very coriaceous-leaved form that lacks tomentose indumentum, grow in the same general area.

In northern Borneo there are some specimens that dry rather similar to the local form of *Calophyllum biflorum*. One of these is *Stevens et al.* 125 (from Sarawak), which has the bark and slash characters of *C. teysmannii* var. *inophylloide*. Another, *S* 1013 (from Brunei), has leaves drying somewhat like those of *C. ferrugineum* var. *orientale* (close to *C. biflorum*, see below), as well as the inconspicuous tomentose indumentum of that species. However, the hairs have many expanded, rather thin-walled apical cells in comparison to the two to four thick-walled cells found in *C. ferrugineum* var. *orientale*. The field characters of *S* 1013 are those of *C. teysmannii*.

On the lower slopes of Mt. Kinabalu, Sabah, and on Mt. Kemoel, Kalimantan, there is perhaps another form of *Calophyllum teysmannii* var. *inophylloide* ("k" in the above list). In the young plants the terminal buds are protected by the petiole bases (*Stevens et al.* 495), and the hair, bark, and slash characters are compatible with those of this variety. However, the only specimen with flowers (*Clemens* 40003) has puberulo-tomentose indumentum on the inflorescence axis and pedicels, and the flowers have 175 to 325 stamens. Fruits are unknown. More collections of this form are needed to establish its status; it has not been incorporated in the description.

#### Synonymy and Nomenclature

There is no doubt about the synonymy of the names listed under *Calophyllum teysmannii* var. *teysmannii*. The type specimen of *C. teysmannii* has rather small, obovate leaf blades with a prominent thickened band at the margin, and inflorescences with few rather large, long-pedicel flowers. *Calophyllum intramarginale* was described from similar specimens that were growing at lower altitudes, but that otherwise closely match the type specimen of *C. teysmannii*.

The publication of *Calophyllum teysmannii* Miq. just antedates that of *C. teysmannii* Zoll. ex Planchon & Triana. That part of the supplement to Miquel's *Flora Indiae Batavae* in which the name *C. teysmannii* Miq. is validly published came out in December, 1861 (the name is also mentioned on p. 193 of the supplement published in June, 1861 (Stafleu, 1967)). However, the portion of Planchon and Triana's "Mémoire sur la famille des Guttifères"



in which the name *C. teysmannii* Zoll. ex Planchon & Triana was published appeared early in 1862.<sup>14</sup> *Calophyllum teysmannii* Zoll. ex Planchon & Triana is itself a superfluous name for *C. dasypodum* (q.v.).

*Calophyllum marginatum*, a manuscript name of Wallich, has been something of a mystery to earlier authors. Vesque (*loc. cit.*) said that the name made him think of *C. pulcherrimum* (properly *C. tetrapterum*), the leaves of which often have a pale margin. However, the specimen of *Wallich dist. 4845* at Kew was taken from a young plant of *C. teysmannii* var. *inophylloide* and has a thickened leaf margin, lines across the twigs at the nodes, and purselike galls.

79. *Calophyllum aerarium* P. F. Stevens, sp. nov.

FIGURE 26, b.

A speciebus aliis *Calophylli* in gemma terminali 0.6–1.5 cm. longa, lamina oblonga vel obovata apice rotundata in siccitate aerata, inflorescentiis axillari-bus puberulentibus, et fructu circa 2 cm. longo in siccitate arcte rugoso strato exteriori valido circa 1.3 mm. crasso putamine parietibus tenuissimis, differt.

Tree ca. 30 meters tall, d.b.h. ca. 50 cm.; trunk and bark unknown; latex yellow.

Twigs flattened, 2.5–4 mm. across,  $\pm$  4-angled when young, often with obscure horizontal line at nodes, drying brown, transiently brown-farinose; axillary innovations lacking basal scars, internodes (1–)2–8.5 cm. long; uppermost pair of axillary buds rounded to pointed, 1–3 mm. long, spreading, conspicuous; terminal bud narrowly conical, 0.6–1.5 cm. long, with brown,  $\pm$  furfuraceous indumentum (hairs, FIGURE 27, s, t), underdeveloped internode 1–3 mm. long. Petiole 1–3 cm. long, shallowly concave above, convex below, drying blackish, transiently farinose; lamina obovate or suboblong to elliptic, 6.5–14 by 3.5–7 cm., broadly rounded at apex, whether or not apiculate, acute at base, rather deeply but distantly undulate and strongly recurved at margin, coriaceous, drying umber above and sabelline-sepia below,  $\pm$  transiently farinose on midrib on both surfaces, the midrib above narrowing gradually from base,  $\pm$  flat at first, center sulcate, becoming raised (surrounding lamina obscurely raised), 0.2–0.4 mm. wide at midpoint, below raised, angled (rounded toward base), venation  $\pm$  apparent above and below, raised, 6 to 10 veins/5 mm., angle of divergence 65–76°. Infructescences from uppermost foliate axils, with ca. 5 flowers, unbranched, the axis 2–3.5 cm. long, puberulent, lowest internode 0.4–2.2 cm. long; bracts unknown; pedicels 4–10 mm. long,  $\pm$  puberulent. Only damaged flowers known, (?)hermaphroditic;

<sup>14</sup>The type specimen of *Quiina decaisneana* Planchon & Triana, published in the same part of Planchon and Triana's article (p. 315), is cited as "Guyana (Melinon, serres du Muséum, 1862)." In an earlier article in the same volume (H. F. Hance, "Symbolae ad floram Sinicam," pp. 220–230), specimens are cited as having been collected in Canton as late as October, 1861 (p. 229), while on page 220 Hance wrote "*Whampoa sinensium* Scripsi m. Nov. 1861. H. F. H." This makes a publication date of early 1862 for Planchon and Triana's article very probable. (I am extremely grateful to Dr. H. Heine, Paris, for drawing this evidence to my attention.)

tepals 6 (?always), the outer pair broadly ovate, ca. 6 by 7.5 mm., puberulent on back, the inner ones to 13 by 6.5 mm.; stamens numerous, the filaments to 4.5 mm. long, the anthers oblong, ca. 1.2 mm. long, retuse at apex; ovary ca. 2.5 mm. long, style and stigma unknown. Fruit  $\pm$  spherical, ca. 2.1 by 1.9 cm., apiculate, young fruit ovoid and sharply apiculate, drying brown, closely, sharply, and rather shallowly wrinkled; outer layer not detaching cleanly from stone, ca. 1.3 mm. thick, compact and very tough; stone spherical, ca. 1.6 cm. long and across, rounded at apex, the walls less than 0.05 mm. thick, smooth, (?)unmarked; spongy layer thin.

TYPE: Celebes, Malili, Oesoe, 100 m., 2 May 1921, *Cel./II-354* coll. *Waturandang* (holotype, BO).

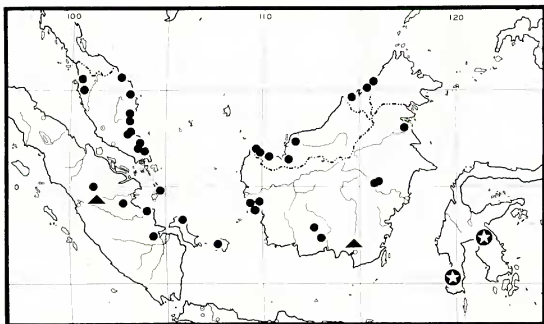
DISTRIBUTION. Celebes (MAP 27).

ADDITIONAL SPECIMENS SEEN. **Celebes.** SULAWESI: Malili, Oesoe, 100 m., *Cel./II-354* coll. *Reppie* (BO), *Cel./II-354* coll. *anon.* (A, L); Pankadjene, *Teysmann*, *HB 12086* (BO); Baleh-angien, *Teysmann*, *HB 12496* (BO).

ECOLOGY. Fruiting in February.

Crateriform, pustular galls occur just in from the margin on the lower surface of the lamina in *Cel./II-354* coll. *Waturandang*.

*Calophyllum aerarium* can be recognized by its long, narrow, terminal bud; its long petioles; its fairly large, obovate to elliptic lamina that is broadly rounded at the apex (whether or not the very apex is apiculate); its axillary, puberulent inflorescences; and its closely wrinkled fruit with a well-developed, compact, very strong outer layer and a very thin stone wall. The leaves



MAP 27. Distribution of *Calophyllum sclerophyllum* (circles, localized specimens; triangles, unlocalized specimens) and *C. aerarium* (stars in solid circles) in Malesia.

dry a color close to bronze, hence the specific epithet *aerarium* ("made of copper or bronze").

*Calophyllum aerarium* is superficially like *C. alboramulum*, but the latter has uppermost axillary buds that are suberect, leaf blades that are acuminate at the apex, twigs that dry a paler color, and terminal inflorescences. It also approaches *C. sclerophyllum*, but can be distinguished by its larger flowers and hairs, longer terminal buds, and thinner leaves drying a different color.

80. *Calophyllum celebicum* P. F. Stevens, sp. nov.

FIGURE 28, a-c.

A speciebus aliis Calophylli in ramulis valde 4-angulatis, lamina suboblonga plus minusve valde coriacea spissescenti marginali 0.5-0.8 mm. lati, floribus cum 8 tepalis, fructu strato exteriore valido 1-1.2 mm. crasso, putamine parietibus tenuissimis, differt.

Tree 20-30 meters tall, d.b.h. to 50 cm.; trunk and outer bark not known; latex yellow to yellowish pink.

Twigs slightly flattened, 3.5-5.5 mm. across, strongly and persistently 4-angled to 4-alate, drying blackish brown to blackish, transiently brown-farinose; axillary innovations lacking basal scars; internodes 1-3.5 mm. long; uppermost pair of axillary buds subrounded, ca. 1(-2) mm. long,  $\pm$  spreading, inconspicuous; terminal bud plump, 7-9 mm. long, with crustaceous, gray to brown indumentum (hairs, FIGURE 22, r-t; some also moruloid), underdeveloped internode 1-3 mm. long. Petiole 0.8-2 cm. long, broadly and shallowly concave above and convex below, glabrous, drying black; lamina oblong or elliptic to obovate, (7.5-)10-20.2 by (3.7-)4.6-9.6 cm., rounded (rarely obtuse or shallowly retuse) at apex, cuneate to broadly rounded at base, slightly and distantly undulate and somewhat recurved at margin, marginal thickening 0.5-0.8 mm. wide, very coriaceous, drying sepia above and amber below, transiently to subpersistently farinose on midrib below, the midrib above usually abruptly narrowed at (rarely narrowing gradually from) base, depressed, the margins raised or not, 0.35-0.6 mm. wide at midpoint, becoming slightly raised toward apex, below raised, angled, but striate toward base, the venation subapparent above and apparent below, raised, 5 to 8 (to 10) veins/5 mm., angle of divergence 65-75°. Inflorescences from foliate axils, with 7 to 9 flowers, sometimes flabellate, unbranched, the axis 2.2-5.5 cm. long, sparsely farinose, especially toward base, lowest internode 0.4-1.3 cm. long; bracts ovate, to 5 mm. long, deciduous; pedicels ca. 1 cm. long,  $\pm$  glabrous, in fruit 1.8-2.6 cm. by up to 3.5 mm. Flower known only in bud, (?)hermaphroditic; tepals 8, inner ones glabrous; stamens ca. 150, the anthers oblong, 1-1.6 mm. long; stigma peltate, ca. 0.7 mm. across. Fruit ovoid to ellipsoid, 2-2.3 by 1.6-1.7 cm., rounded to acute at apex, drying brown, finely striate; outer layer not detaching cleanly from stone, 1-1.2 mm. thick, compact, tough; stone ca. 1.7 by 1.3 cm., rounded at apex, the walls less than 0.1 mm. thick, smooth, (?)unmarked; spongy layer thin.

TYPE: Celebes, Ond. Malili, Oesoe, 200 m., 27 Jan. 1934, *Cel./II-213* coll. Waturandang (holotype, A; isotype, BO).

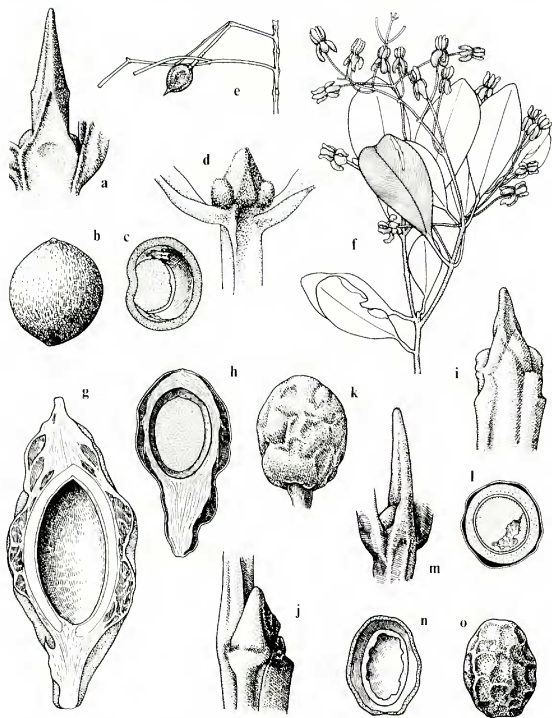


FIGURE 28. a-c, *Calophyllum celebicum* (Cel./II-213). a, terminal bud,  $\times 3$ . b, c, fruit,  $\times 1$ : b, from outside; c, transverse section. d-f, *C. ceriferum*. d, f, *Poilane* 6172: d, terminal bud,  $\times 6$ ; f, habit,  $\times 0.5$ . e, *Robinson* 1748, young infructescence,  $\times 0.5$ . g, h, *C. macrocarpum*, fruit, longitudinal section,  $\times 0.5$ ; g, *FRI* 10926; h, *S* 15898. i, *C. calcicola* (*Kostermans* 14022), terminal bud,  $\times 6$ . j-l, *C. havilandii* (*SAN* 17449). j, terminal bud,  $\times 6$ . k, l, fruit,  $\times 1$ : k, from outside; l, transverse section. m-o, *C. sundaicum*. m, *SFN* 34807, terminal bud,  $\times 3$ . n, o, *SFN* 26047, fruit,  $\times 1$ : n, longitudinal section; o, from outside.

DISTRIBUTION. Sulawesi (MAP 26).

ADDITIONAL SPECIMENS SEEN. **Celebes.** SULAWESI: Ond. Malili, Oesoe, 200 m., *Cel./II-211* (A, BO, L), *Cel./II-212* (A, BO), 300 m., *Cel./II-214* (BO, L), *Cel./II-431* coll. *Reppie* (BO, K, L), 30 m., *bb 32471* (BO, L), Kawatta, *Cel./II-431* coll. *Waturandang* (BO), nabij la Rana, *bb 1821, 1822, 1827* (all BO); Manado, Kolonedale, Pompangeo gebergte, *bb 30150* (BO, L, SING).

ECOLOGY. Forest, 30–300 m. alt. Flowering (specimens in bud) December and January; fruiting in January.

LOCAL USE. Latex produced from the stem is used for torches.

*Calophyllum celebicum* can be recognized by its dark-drying, strongly four-angled twigs; its coriaceous, more or less oblong lamina with depressed midrib and well-marked band of marginal thickening; and its very thin-walled stone that is almost invisible in the mature fruit. The epithet *celebicum* is taken from an old name for Sulawesi, Celebes.

*Calophyllum celebicum* is superficially similar to *C. sclerophyllum*, but in addition to the characters mentioned above, *C. celebicum* has pedicels that are strongly incrassate in fruit, hairs of a different type (cf. FIGURES 22, r–t, and 25, g–i), and spongy mesophyll tissue in the lamina that is not lignified as it characteristically is in *C. sclerophyllum* (Vesque, 1893; pers. obs.). The hair structure and thickened leaf margin of *C. celebicum* suggest a closer relationship to *C. teysmannii* var. *inophylloide*, but the midrib, pedicel, and fruit characters mentioned above clearly separate the two.

The specimen *bb 30150* has a more delicate appearance than do the others, but, like them, has a lamina with a prominent, thickened margin.

81. *Calophyllum sclerophyllum* Vesque, *Epharmosis* 2: t. 33. 1889, in C. DC. Monogr. Phanerog. 8: 587. 1893; Merr. Bibl. Enum. Born. Pl. 394. 1921; Masamune, Enum. Phanerog. Born. 476. 1942; Heyne, Nutt. Pl. Indonesië, ed. 3. 1: 1085. 1950 ("an *C. sclerophyllum* Vesque?"); M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 324. 1956; J. Anderson, Gard. Bull. Singapore 20: 154. 1963; Pukol & Ashton, Checklist Brunei Trees, 93. 1964; Ashton, Oxford Forest Mem. 25: pl. 32. 1964; Smythies, Common Sarawak Trees, 64. pl. 22. 1965; Kochummen, Malayan Forest Rec. ed. 2. 17: 214. 1965; T. C. Whitmore, Tree Fl. Malaya 2: 191. 1973; J. Anderson, Trees Peat Swamp Sarawak, 88. 1973; Corner, Gard. Bull. Singapore Suppl. 1: 105. 1978. TYPE: Sarawak, Kuching, Nov. 1886, *Beccari PB 2705* (holotype, P; isotypes, FI, K, M).

*C. rhizophorum* Boerl. & Koord. in Koord.-Schum. Syst. Verzeich. 2: 39. 1910; J. Anderson, Trees Peat Swamp Sarawak, fig. 26C. 1973. TYPE: Sumatra, bei Biwak Soengei Gati, 25 m., 11 March 1891, *Koorders 10333* (holotype, BO).

*C. subfluridum* Wyatt-Smith, Malayan Forest Rec. 17: 113. 1952. *Nomen.* *Calophyllum* sp. prob. *inophyllum* forma, Keith, N. Borneo Forest Rec. ed. 2. 2: 314. 1952.

Tree 7.5–36 meters tall, d.b.h. to 76 cm.; trunk with numerous branching stilt roots to 3.5 m. tall, sometimes with knee roots; outer bark pale gray and pink with lines of lenticels, becoming brown, with rather shallow fissures, scaling, the inner surface brown to blackish; under bark pale red to brownish straw; inner bark red to red-brown; latex yellow or pale yellow, clear, very sticky, “pleasantly scented” (*KEP* 76078); sapwood orange-red; heartwood red-brown, hard.

Twigs flattened, 2.3–5.5 mm. across, rounded to sharply 4-angled, drying blackish (rarely mid-brown), glabrous or transiently subfarinose; axillary innovations lacking basal scars; internodes (0.5–)1–5 cm. long; uppermost pair of axillary buds rounded, to 1(–2) mm. long, spreading; terminal bud plump, 3–9 mm. long, with furfuraceous, grayish indumentum (hairs, *FIGURE* 25, g–i), underdeveloped internode to 3(–7) mm. long. Petiole 0.7–2.5 cm. long, broadly and shallowly concave above, convex below, drying black, glabrous or almost so; lamina obovate to elliptic or oblong, 5.7–21 by 2.5–9.5 cm., rounded to retuse at apex, acute to cuneate at base, or broadly rounded toward base, at base short-attenuate, at most distantly undulate and slightly to strongly recurved at margin, coriaceous, drying umber to olivaceous above, umber to olivaceous or sabelline below, glabrous or sparsely transiently farinose on midrib below, the midrib above usually narrowing rather abruptly near base,  $\pm$  sunken to slightly raised, adjacent lamina often raised, 0.1–0.4 (–0.5) mm. wide at midpoint, below strongly raised, striate to  $\pm$  angled, the venation  $\pm$  apparent on both surfaces, raised, (5 or) 6 to 10 veins/5 mm., angle of divergence 55–80°. Inflorescences from foliate axils along twig, with 7 to 11 flowers, unbranched, the axis 2–8 cm. long, puberulent (only near base), lowest internode 1–6(–15) mm. long; bracts unknown; pedicels 1.5–4.2 cm. long, puberulent to glabrous. Flower (?)hermaphroditic; tepals 8, the outer pair ovate to suborbicular, 4.5–7.5 by 4–7 mm., sometimes puberulent on back, the next pair suboblong, 7–12 by 5–8.5 mm., the inner ones oblong to elliptic, 6–9.5(–12) by 3–4.5(–5.5) mm.; stamens (45 to) 85 to 150, the filaments to 4.5 mm. long, the anthers oblong, 1.6–2.5 mm. long, retuse to strongly retuse at apex; ovary 2–2.5 mm. long, the style to 3 mm. long, the stigma peltate, ca. 2 mm. across, 3-lobed. Fruit ovoid to ellipsoid or spherical, 2.4–3 by 1.9–3 cm., apiculate or not (rarely acute) at apex, drying brown, finely wrinkled or striate; outer layer not detaching cleanly from stone, 1–3 mm. thick, compact, rather hard; stone ellipsoid to spherical, to 2.5 cm. long and across, rounded at apex, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer thin; cotyledons of dried embryo separating easily.

**DISTRIBUTION.** Malay Peninsula (mostly on the eastern coast) to Borneo, excluding Java (*MAP* 27).

**SELECTED SPECIMENS SEEN.** **Malaya.** **KEDAH:** Tasek Gelugor F.R., *KEP* 9839 (*KEP*). **PERAK:** Dindings, State Land Sg. Gelam, 29 m., *KEP* 69429 (*KEP*); Chikus F.R., *KEP* 31043 (?) (*KEP*). **KELANTAN:** 59th mile, Kuala Trengganu–Khota Bharu Road, *FRI* 2529 (K, *KEP*, SAR, SING). **TRENGGANU:** Bukit Bauk F.R., 90 m., *KEP* 76078 (*KEP*); State Land Jerengau, *KEP* 81115 (*KEP*).

PAHANG: Gunong Lesong F. R., Rompin, *KEP 80963* (K, KEP); Sungei Tabing, Kuantan, *KEP 31611* (K, KEP); Perah, Rompin, *KEP 2735* (K, KEP); Pentas Liman, Ulu Rompin, *KEP 2743* (K, KEP, SING); Pekan, 30 m., *KEP 65697* (KEP); Genting Batu (Anak Endau), *KEP 31602* (KEP); Memtelong Ulu Sungei Endau, *KEP 17293* (KEP). JOHORE: Mawai, *SFN 34728* (K, KEP, SING); Jemaluang F.R., 30 m., *KEP 71891* (BO, K, KEP, SING); G. Arong F.R., 15 m., *KEP 76279* (KEP); Sungei Semandan, *Corner s. n.*, 16 June 1934 (KEP, SING); Sungei Sedili, *Corner s. n.*, 29 July 1932 (KEP, SING); Panti F.R., 6 m., *Stevens et al. 114* (A). **Sumatra & adjacent islands.** RIAU: Lingga, Nanggöe, 8 m., *bb 5619* (BO); Indrag. Bovenlanden, Kuala Belilas, 60 m., *bb 27576* (BO, K, L, NY, SING); P. Gelang, *bb 29134* (BO, BRI); Keritang, 5 m., *bb 28677* (BO, SING). DJAMBI: Simpang, 45 m., *bb 12876* (BO). SELATAN: Banjoeasin, en Koeboestreken, 5-20 m., *5 E 1 P 649* (A, B, BM, BO, BRI, L, NY, P, SING). BANGKA: B[e]linjoe, *Grashoff 34* (BO, L); Bikang, *bb 15106* (BO, L). BELITUNG: Tandj. Pandan, Bantan, 30 m., *bb 8391* (BO). **Borneo.** SARAWAK. 1st Division: near Kuching, *Haviland & Hose 3346* (A, BM, BO, K, SAR, UC); Setapok F.R., *S 16169* (L, SAR, SING); Lundu, *S 9774* (BO, K, L, SING); G. Pueh F.R., *S 6249* (SAR, SING). 2nd Division: Betong, Sempadi F.R., *S 12884* (SAR). 3rd Division: Sibü, Daro F.R., *FA 136* coll. *Anderson* (SAR). BRUNEI: Bendaram, *FMS 30397* (K, KEP). SABAH. Beaufort: Kampong Nuparan, 1.5 m., *A 1714* (K, KEP, L); Kimanis Forest Distr., *A 1401* (BO, CANB, K, KEP, SING); Bongawan F.R., *A 398* (A, K, KEP, SING). KALIMANTAN. Timur: Salimbatöe, S. Roemah, 25 m., *bb 11228* (BO); W. Koetei, Moejoep, 40 m., *bb 16730* (A, BO); Kembang Djangoet, *bb 15684* (BO, L). Tengah: Sampit, 3 m., *bb 32410* (BO, L); Kuala Kuajan, 20 m., *Kostermans 8020* (A, BO, CANB, K, KEP, L, LAE, NSW, P, SING); Beneden Djak, Toewanan Is., 6 m., *bb 9444* (BO). Barat: Poeloe Madjang, *Teysmann, HB 8041* (BO, FL, L); Koeboepadi, 5 m., *bb 6365* (BO); Ambawang, 0 m., *bb 13713* (BO).

**ECOLOGY.** Freshwater peat swamps or seasonally inundated forest, rarely on sandy soil (*A 398*, Sabah); to 60(-150) m. alt. On Malay Peninsula and in Sumatra, flowering September to November, fruiting February and March. In Borneo flowering January, March, July, October, and November; fruiting February and March.

Circular, crateriform galls occur in rows on the petiole (*bb 9444*) and along the underside of the midrib (*bb 15106*).

**GERMINATION AND YOUNG PLANT.** The radicle probably breaks through the stone to one side of the base. The seedling has a single pair of leaves, ranging from 11 by 7 cm. (*KEP 31043*) to 5 by 3 cm. (*Stevens 86*). Subsequent leaves produced are alternate, with the stem being notably zigzag (*5 E 1 P 404*, at bo); the terminal bud is functional. It is not known when the transition to opposite leaves takes place, but a young plant almost certainly of this species ca. 1 m. tall and still with alternate leaves was seen in the Setapok Forest Reserve, near Kuching, Sarawak.

**LOCAL NAMES AND USE.** "Bintangor jangkang" (Malaya), "boenoet djankar" (Bangka), "bintangor jankar" (Sarawak), "penaga djanka" (Kalimantan). The wood is hard and heavy and is used in general construction; since it is not attacked by insects, it is durable.

Although there is considerable variation in leaf, flower, and inflorescence size in the specimens of *Calophyllum sclerophyllum* cited above, they all agree in their coriaceous, rather coarsely veined leaf blades that dry olivaceous; rather short, grayish terminal buds; and stout twigs. The plant often (?always) has stilt roots and usually grows in freshwater swamps (see Ashton, *loc. cit.*, for a good photograph of the stilt roots). Despite the variation in flower size, there are only a moderate number of stamens, and the anthers are large and are often strongly retuse. The fruits are quite large and have a well-developed, compact, and rather hard outer layer and a stone with thin walls. The specific epithet *sclerophyllum* refers to the stiff, coriaceous leaf blades.

Specimens of *Calophyllum sclerophyllum* from Borneo, including the type, have glabrous flowers and inflorescences (except for the fringe of short hairs on the edges of the tepals and the slight puberulence at the base of the inflorescence), while specimens from elsewhere have puberulent indumentum on the inflorescence axis, the pedicels, and the backs of the outer tepals. However, *Kostermans 8020*, from Kalimantan, has slight puberulence at the base of the outer tepals and on the adjacent pedicel. Specimens from Sumatra and Borneo usually have spots on the lower surface of the lamina; these are visible in the field as well. Specimens from Malaya are not usually spotted.

The report of *Calophyllum sclerophyllum* from Papuasias (Stevens, 1974a, as *C. rhizophorum*, based on *Pleyte 762* (A, BO, BRI, K, L, SING)) is incorrect. *Pleyte 762* lacks the lignified spongy mesophyll characteristic of *C. sclerophyllum* (see also Vesque, 1889, *loc. cit.*; 1893, *loc. cit.*). I have not seen any other specimens matching *Pleyte 762*.

The type specimen of *Calophyllum rhizophorum*, which lacks flowers and fruits, is a good match with other specimens of *C. sclerophyllum*, although the twigs have dried somewhat lighter brown than is usual.

82. *Calophyllum havilandii* P. F. Stevens, sp. nov.

FIGURE 28, j-l.

*C. rhizophorum* auct., non Boerl. & Koord.; Pukol & Ashton, Checklist Brunei Trees, 93. 1964; Smythies, Common Sarawak Trees, 61. 1965; J. Anderson, Trees Peat Swamp Sarawak, 87. 1973, *excl. icon*.

A *Calophyllum sclerophyllum*, quo ut videtur simile est, in gemma terminali basibus petiolorum inclusa (in *C. sclerophyllum* haud incluso), lamina vena submarginali provisa (haud provisa), inflorescentia internodia basali 3-7.5 cm. longa (usque ad 1.5 cm. longa), et fructus rugoso (laevi), differt.

Tree 18-27 meters tall; trunk without buttresses; outer bark yellowish brown, chocolate brown, or pale black, fissured, in large trees with scales; inner bark red, slightly lamellate; latex yellow or pale yellow, clear or opaque, sticky.

Twigs slightly flattened, 1.8-4 mm. across, 4-angled, drying blackish brown, transiently sparsely puberulent; axillary innovations lacking basal scars; internodes 1-3.5(-11) cm. long; the uppermost pair of axillary buds rounded, to 0.5 mm. long, inconspicuous; terminal bud conical, 2-4 mm. long, with



subadpressed, brown indumentum (hairs, FIGURE 25, j), underdeveloped internode absent. Petiole 1–1.6 cm. long, shallowly concave to flat above and convex below, glabrous, drying black; lamina obovate to suboblong, 5.4–14.5 by 3.3–7 cm., slightly retuse at apex, cuneate to broadly rounded and ultimately short-attenuate at base, not undulate and not recurved to slightly so at margin, marginal thickening ca. 0.6 mm. wide, coriaceous, drying umber above and sepia below, transiently sparsely puberulent on midrib below, the midrib above gradually narrowed from base,  $\pm$  flat at first, becoming slightly raised, 0.2–0.4 mm. wide at midpoint, below raised, striate, the venation subapparent on both surfaces, raised, 4 to 7 veins/5 mm., angle of divergence ca. 60°. Inflorescences from foliate axils along twigs, with 5 to 9 flowers, unbranched, the axis 7–14.5 cm. long, glabrous, lowest internode 3–7.5 cm. long; bracts elliptic, to 4.5 mm. long, deciduous; pedicels 1.8–4 cm. long, glabrous. Flower (?)hermaphroditic; tepals 4, the outer pair ovate to elliptic, 7–9.5 by 4.5–6 mm., the inner pair obovate, ca. 13 by 8 mm.; stamens 175 to 200, the filaments to 7 mm. long, the anthers oblong, 1.7–2 mm. long, shallowly retuse at apex; ovary ca. 2.2 mm. long, the style ca. 5.5 mm. long, the stigma peltate, ca. 2 mm. across, 3- or 4-radiate. Fruit ellipsoid, ca. 2.1 by 1.7 cm., rounded at apex, drying brown, rather distantly and deeply wrinkled; outer layer detaching cleanly from stone, ca. 2 mm. thick, compact except for air spaces developing under skin; stone ellipsoid, ca. 1.5 by 1.15 cm., rounded at apex, the walls ca. 0.15 mm. thick, smooth, unmarked; spongy layer at first thick.

TYPE: Sarawak [1st Division], near Kuching, 24 Nov. 1894, *Haviland & Hose* = 3345 (holotype, GH; isotypes, BO, P, W).

DISTRIBUTION. Northwestern Borneo (MAP 30).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 1st Division: near Kuching, *Haviland & Hose* 3345 (BM, K, L, SAR, UC), near G. Siol, *Omar* 372 (K, SING); Stapok F.R., 15 m., *Stevens et al.* 149 (A). 3rd Division: Sungei Tutus Logging Camp, Btg [Batang] Igan, *S* 30557 (SAR); Sibul, Loba Kabang South Protected Forest, *KEP* 79328 (KEP, SAR), *S* 654 coll. *Anderson*, 13 Jan. 1954 (KEP, SAR, SING); Merurong Plateau, 762 m., *S* 18706 (SAR); Lassi, 1100 m., *S* 756 coll. *Sulhi*, 27 Feb. 1954 (SAR); Sungei Assan, *S* 30569 (SAR). 5th Division: Kayangeran F.R., *S* 2843 (SAR). **BRUNEI:** Kuala Belait, Babas State Land, 6 m., *SAN* 17449 (A, BO, K, KEP, L, P, SING). **SABAH.** Sipitang: Mengalong F. R., 3–7.5 m., *SAN* 22316 (SAN, SING).

ECOLOGY. Peat swamps, low alt.; once in kerangas forest, 762 m. alt.; once in swamp, 1100 m. alt. Flowering in November; submature fruit in April.

GERMINATION AND YOUNG PLANT. Young plants are little branched, with the first branch 1.5–3.5 meters above the ground. The terminal bud is functional, and the plant is erect. (*Stevens et al.* 149.)

LOCAL USE. The wood is used for planks.

*Calophyllum havilandii* superficially resembles *C. sclerophyllum*, with which it has been confused. However, there are numerous differences between the two, and they are probably not closely related. Dried specimens of *C. havilandii* are darker in color than those of *C. sclerophyllum*. In older leaves of *C. havilandii* there is a clear submarginal vein; the leaf blade and the marginal thickening are thinner than in *C. sclerophyllum*, and the vascular bundle embedded in the thickening is farther away from the margin—thus the position of the bundle is not obscured by the thickening. *Calophyllum havilandii* appears to lack a hypodermis and to have very tall epidermal cells with thickened anticlinal walls. However, these “cells” can be seen under high magnification to be divided by unthickened periclinal walls, while the hypodermis of *C. sclerophyllum* is two-layered, with all walls subequally thickened. In addition, *C. havilandii* lacks the thickened spongy mesophyll of *C. sclerophyllum* (see also Vesque, 1889, 1893). The basal internode of the inflorescence axis in *C. havilandii* is characteristically long; that of *C. sclerophyllum* is less than 1.4 cm. Finally, there are important differences in the fruit: *C. havilandii* lacks the strong outer layer of *C. sclerophyllum*, and air spaces develop under the skin of the dried fruit, making it deeply wrinkled. This contrasts with the darker, smooth fruit of *C. sclerophyllum*. Although young plants of the two species are not well known, those of *C. havilandii* are robust and have opposite leaves, while those of *C. sclerophyllum* are weaker and have alternate leaves. Stilt roots have not been reported for *C. havilandii*, although they are usually (perhaps always) present in *C. sclerophyllum*.

The specific epithet commemorates G. D. Haviland.

83. *Calophyllum macrocarpum* Hooker f. Fl. Brit. India 1: 273. 1874; King, Jour. Asiatic Soc. Bengal, II. 59: 179. 1890; Vesque in C. DC. Monogr. Phanerog. 8: 603. 1893; Ridley, Jour. Straits Branch Roy. Asiatic Soc. 33: 48. 1900, Fl. Malay Penin. 1: 187. 1922; M. R. Henderson, Gard. Bull. Straits Settl. 4: 224. 1928; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 317. 1956; Kochummen, Malayan Forest Rec. ed. 2. 17: 218. 1965; I. H. Burkill, Dict. Econ. Prod. Malay Penin. ed. 2. 1: 416. 1966; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 16. 1967; T. C. Whitmore, Tree Fl. Malaya 2: 187. 1973; H. Keng, Gard. Bull. Singapore 28: 244. 1976; Corner, Gard. Bull. Singapore Suppl. 1: 104. 1978. TYPE: Malaya, Malacca, 30 July 1867, *Maingay* 1728 (*Kew dist.* 174) (lectotype, K). FIGURE 28, g, h.

*C. horstii* Boerl. Catal. Horto Bogor. 2: 79. 1901; Merr. Bibl. Enum. Bornean Pl. 393. 1921; Masamune, Enum. Phanerog. Born. 475. 1942. TYPE: Java [seed from Borneo], 20 May 1898, cult. hort. Bogor. sub numero VI C 39 (lectotype, BO).

*Calysaccion horstii* Teijsm. & Binn. Catal. Horto Bogor. 205. 1866. *Nomen*.

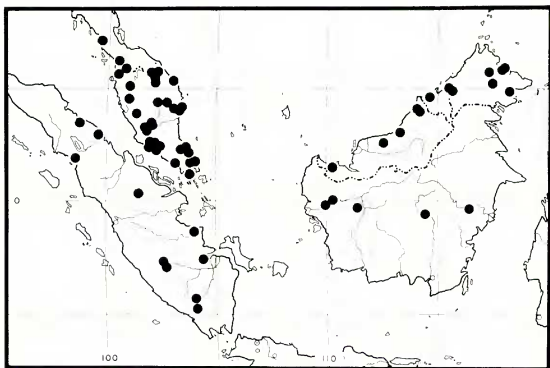
Tree 8–45(–?60) meters tall, d.b.h. to 77 cm.; trunk usually without buttresses (small buttresses present); outer bark yellowish brown at first, becoming dark brown to blackish, with boat-shaped fissures (scaling on ridges), the

inner surface mid-brown to blackish and orange mottled; under bark reddish; inner bark red; latex orange, clear (becoming cloudy later), or gummy, pinkish (*SAN 51223*); sapwood light brown; heartwood dark brown, hard.

Twigs slightly flattened, 2.5–5 mm. across, sharply 4-angled, drying [brown] dark brown or blackish, with transient, sparse, brown hairs to 0.5 mm. long; axillary innovations lacking or with up to two pairs of basal scars; internodes 0.5–2.5(–5) cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, inconspicuous; terminal bud plump, [1.8–]3.5–5.5(–9) cm. long, with brown, short, tomentose indumentum (hairs, FIGURES 27, q, r; 29, a, b), underdeveloped internode not apparent. Petiole (1.3–)2.5–5.3 cm. long, flat to shallowly concave above, convex below, glabrous, drying black [to brown]; lamina oblong to elliptic (rarely ovate to obovate), 8–25(–35) by 2.3–8.5(–9.2) cm., usually shortly and bluntly acuminate (rarely acute) at apex, acute (cuneate) at base, slightly recurved or not and barely undulate at margin, coriaceous, drying bay to umber above and umber to sepia below, glabrous or sparsely tomentose on midrib below, the midrib above gradually narrowed from base, raised or not (surrounding lamina raised), 0.2–0.8 mm. wide at midpoint, below raised, rounded to striate, the venation above and below usually apparent, raised [sometimes much reticulated and joining submarginal vein], (4 or) 5 to 10 (to 13) veins/5 mm., angle of divergence (50–)65–80°. Inflorescences from foliate axils, with (3 to) 7 to 15 flowers, unbranched or with occasional 3-flowered branches up to 5 mm. long, the axis 1.2–4.5[–7] cm. long, ± densely brown-tomentose toward base, glabrous above or not, lowest internode 0.2–1.2 cm. long; bracts unknown; pedicels [0.4–]1–3.2 cm. long, very short-tomentose to glabrous. Flower (?)hermaphroditic; tepals 8 (rarely 10), the outer pair broadly ovate, 9–13 by 7.5–11 mm., glabrous or densely puberulent on outer (and inner) surface, the inner ones ovate to elliptic or lingulate, 11–15 by 2.5–8 mm., two outer usually with band of indumentum down back; stamens 230 to 340, the filaments to 6 mm. long, connate for up to 1.2 mm., the anthers oblong, 1–2.1 mm. long, ± retuse at apex; ovary 1.8–2.3 mm. long, the style 3.5–6 mm. long, the stigma peltate, 1.3–1.5 mm. across, 3- (to 5-)radiate. Fruit ellipsoid, 8–12.7 by 4.5–6 cm., acute at apex, drying dark brown, irregularly and coarsely wrinkled and regularly and finely longitudinally striate; outer layer not detaching cleanly from stone, 3–8 mm. thick, not compact, with large air spaces developing, very fibrous; stone ellipsoid, 3.7–6.7 by 2.2–3.4 cm., rounded at apex, borne in center of fruit, with fibrous zone 2–2.5 cm. long between stone and base of fruit, the walls ca. 0.4 mm. or 1.6–3.5 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southern Thailand and Malaya to Borneo, excluding Java (MAP 28).

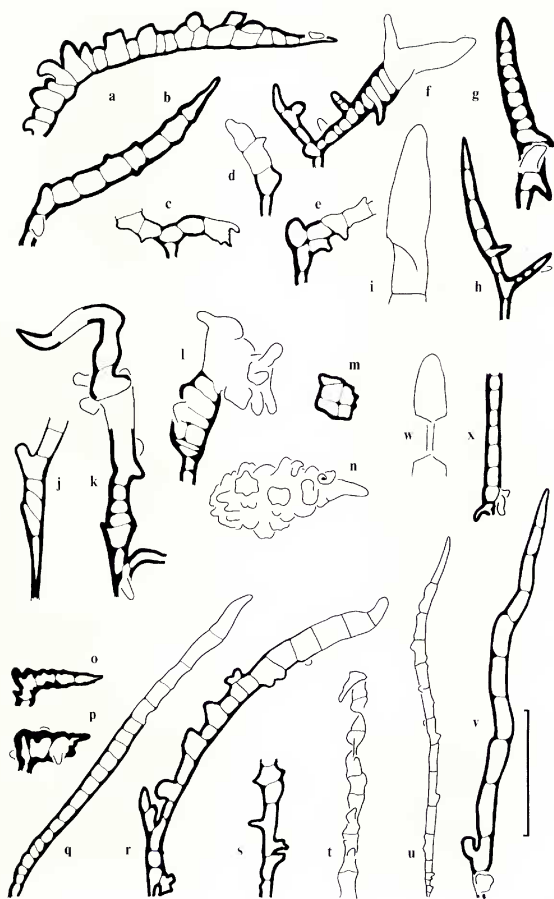
SELECTED SPECIMENS SEEN. **Thailand:** Peninsula, Trang, Khao Chong, *Phusomsaeng & Smitinand* 240 (AAU, BKF, C, E, L, F). **Malaya.** KEDAH: Sik Dalam, *KEP 73822* (KEP); Perangin F.R., *KEP 79282* (KEP); Jeriang, Kuala Muda, 60 m., *KEP 73829* (KEP); Kokmoh F.R., *KEP 47869* (KEP). PERAK: Slim Hills F.R., 605 m., *FRI 708* (K, KEP); Pernam R., 60–90 m., *King's collector 8851*



MAP 28. Distribution of *Calophyllum macrocarpum* in Malaysia.

(K); Lenggong, Ulu Luat, *KEP 10368* (KEP); Parit, *KEP 39466* (KEP). SELANGOR: Bukit Lagong F.R., *KEP 94619* (K, KEP); Ulu Selangor, Batang Kali F.R., *KEP 64219* (KEP); Rantau Panjang F.R., *KEP 28915* (KEP); Ulu Langat, *KEP 63602* (KEP); Sungei Buloh F.R., *KEP 43627* (KEP); Ayer Itam F.R., *KEP 53685* (KEP); Public Gardens, Kuala Lumpur, *KEP 1185* (KEP). NEGERI SEMBILAN: Bukit Tangga, *Ridley s.n.*, 20 Dec. 1920 (K); Sungei Menyala, *KEP 43664* (KEP); Seremban, Port Dickson, *KEP 70472* (KEP); Sertis F.R. quarters, Kuala Pilah, *KEP 94057* (K, KEP). MALACCA: Bukit Sedanan F.R., *KEP 18278* (KEP). KELANTAN: Kemahang North F.R., 30 m., *KEP 65184* (KEP); Machang, Ulu Sat., 365 m., *KEP 118263* (KEP); Sungei Lebir, 2.4 km. S. of Kuala Teryna, *KEP 115987* (A, K, KEP, SAR, SING); Ulu Sungei Aring, near Kuala Tapah, *FRI 7165* (A, K, KEP, SAR, SING); Olak Jeram, Sungei Rek, 90 m., *KEP 65164* (KEP); Chabang Tongkit F.R., 210 m., *KEP 79208* (KEP). TRENGGANU: Kuala

FIGURE 29. Hairs (from terminal bud, unless otherwise noted). a, b, *Calophyllum macrocarpum*: a, *S 15898*; b, *122 E 1 P 788*. c-e, *C. sundaicum* (*bb 18386*), apical cells usually expanded and thin walled. f-i, *C. costulatum* (*Kadim & Noor 371*): i, terminal cell of hair from pedicel. j-l, *C. biflorum*, apical cells often notably birefringent: j, *S 15241*; k, *SFN 39532*; l, *SAN 83235*. m, *C. mukunense* (*Kostermans 7525*), axillary bud, hair from above. n, *C. subsessile* (*King's collector 6877*), surface view. o-q, s-u, *C. venulosum* var. *venulosum*. o, *Williams 2339*; p, *bb 2974*; q, *Forbes 3069*. s-u, *S 26260*: s, base of hair ca. 690  $\mu$ m. long; t, apex of hair ca. 750  $\mu$ m. long. r, v-x, *C. pentapetalum*. r, v, var. *cumingii*: r, *BS 27148*; v, *Merrill 609*. w, x, var. *pentapetalum* (*Species Blancoanae 969*), apex and base of hair ca. 860  $\mu$ m. long. Scale = 120  $\mu$ m. (in n, scale = 60  $\mu$ m., in u = 240  $\mu$ m.).



Trengganu, *KEP* 76078 (KEP). PAHANG: Baloh F.R., *KEP* 3139 (KEP, SING); Kuantan, Bukit Berserah F.R., *KEP* 65678 (KEP); Kemasul F.R., *KEP* 10667 (K, KEP, SING); G. Tapis, 792 m., *FRI* 10926 (K, KEP, SAR, SING); Rotan Tunggul Reserve, *KEP* 28497 (KEP); Bukit Kajang, 240 m., *KEP* 40529 (KEP); Kiri State Land, *KEP* 40338 (KEP); Kuala Tahan, King George Vth Park, *KEP* 84969 (KEP); Jeriang, Enggang F.R., *KEP* 55732 (KEP); Taman Negara Permatang Terusek, 150 m., *FRI* 4711 (KEP, SING); Bentong, Clough F.R., *KEP* 78708 (KEP). JOHORE: Sungei Kayu, Mawai-Jemaluang Road, *SFN* 32240 (SING); above Danau, Sungei Sedili, *SFN* 37108 (SING); Mersing, Endau, *KEP* 70122 (BO, KEP, SING); G. Panti F.R., 150 m., *KEP* 92446 (KEP); Banang F.R., *KEP* 79563 (KEP); Kota Tinggi, *Ridley* 15446 (BM, K, SING); Bukit Tana Abang, *Lake & Kelsall* 4054 (K, SING). **Singapore:** Changi, *Goodenough s.n.*, 26 June 1889 (SING); Botanic Gardens, Lawn C, *SFN* 34522 (cult.) (BO, K, KEP, SING). **Sumatra.** RIAU: upper Riau, Pakanbaru, Tenajan R., low alt., *Soepadmo* 87 (B, BO, C, E, L, LAE, SING). DJAMBI: Simpang, 45 m., *bb* 13114 (BO). SELATAN: Banjoeasin, Koeboestreken, 15 m., *122 E 1 P* 788 (A, K, L); Boeschproefstation, Lematang Ilir, G. Megang, 75 m., *122 E 3 P T* 277 (B, BO, BRI, NY, P, SING); Rawas, 100 m., *Grashoff* 1044 (BO, L); Moera Doea, Mahanggin, 566 m., *bb* 9247 (BO); Bigu Lelok, 150 m., *Forbes* 3252 (A, BM); Lematang Oeloe, Loeboek Betoeang, 400 m., *TB* 662 (BO); Moesi Ilir, 9 m., *TB* 1102 (BO); Lais, Talang Banal, 250 m., *bb* 8802 (BO). UTARA: Sibolga, Baroes, Koeboen (M. Tapoes), 0 m., *bb* 31026 (A, BO); Bangoean Perba, 660 m., *bb* 8659 (BO); Asahan, Sempang Toba, 50 m., *bb* 10435 (BO). **Borneo.** SARAWAK. 1st Division: Kuching, 3rd Mile, Matang Road, *Omar* 360 (K, SING). 3rd Division: Ulu Arip, Balingian, *Ashton* 6003 (A). 4th Division: Bintulu, Nyabau F.R., *S* 15898 (A, BO, K, SAN, SAR, SING), 50 m., *Hou* 340 (A) (A, C, K). BRUNEI: Andalau F.R., *S* 21579 (K, L, SAN, SAR, SING), 30 m., *Ashton s.n.*, July 1959 (a) (SAR). SABAH. Sipitang: Ulu Mendalong, 9.5 km. SSE. of Malaman, 533 m., *SAN* 16764 (BO, BRI, KEP, L, SING); Bukit Sambantongan, 30 m., *SAN* 27972 (KEP, SAN, SAR). Labuk & Sugut: Bontu Trail, Telupid, 60 m., *SAN* 59310 (SAN); SE. Bukit Tangkunan, Mile 85 Labuk Road, *SAN* 53543 (SAN). Sandakan: Sepilok F.R., *SAN* 39395 (SAN); SW. of Karamuak, Tongkabir, Bukit Mantus, *SAN* 51223 (SAN). Lahad Datu: Kennedy Bay, 210 m., *SAN* 34804 (SAN). KALIMANTAN. Timur: W. Koetai, bij Lahoem, 10 m., *Enderi* 1834 (BO, K, L). Tengah: Poeroek Tjahoe, Tahoedjan, 150 m., *bb* 21160 (BO, L). Barat: Melawi, B. Watas Emang nabij Kg. Betoeang, 175 m., *bb* 26852 (BO, L, MO); Sanggau, Semrangkai, 100 m., *bb* 7022 (BO); Soengei Kapoeas, *bb* 2030 (BO). **Java.** BARAT: Bogor (cult.), *VI C* 42 (BO), *VI C* 115 (BO).

**ECOLOGY.** Mixed dipterocarp forest, often by streams (Henderson & Wyatt-Smith, *loc. cit.*), also colline forest on ridges, poor lowland forest on acid, sandy soil, and forest on periodically inundated ground; to 792 m. alt. Flowering January, April to August, and November (flower scented); fruiting December, January, and July to September. At least outer layer of fruit appears edible: "orange sap at cambium pericarp of fruit may be eaten" (*FRI* 7156); "fruit green, edible and with a sweet somewhat fibrous flesh" (*S* 21579). In Malaya, fruit eaten by squirrels (*FRI* 12284); Ridley (1930) suggested that they are dispersed by rivers.

**YOUNG PLANT.** Leaves of young plants are 15–40 by 1.6–6 cm. (Sarawak).

LOCAL NAMES AND USES. *Calophyllum macrocarpum* is usually called "bintangor bunut" in Malaya, and variants of "bunut" ("boenoet," "boeroe") have been recorded from Kalimantan. The wood is hard and is used to build houses and make furniture.

*Calophyllum macrocarpum* is an easily recognized species, with its black-drying, strongly angled twigs; its long, slender, black-drying petioles, its strongly angled inflorescence axis; and its very large, ellipsoid fruits with a very fibrous outer layer. In Sabah at least, fallen leaves are not quite so readily identified, since the characteristic petiole decays rapidly. *Calophyllum macrocarpum* has the largest fruits in the genus, so its specific epithet is appropriate.

There is considerable variation within *Calophyllum macrocarpum*. Specimens from Thailand and the Malay Peninsula have very thick-walled stones and a moderately fibrous outer layer (FIGURE 28, g). In at least parts of Borneo the stone walls in ripe fruits are only ca. 0.4 mm. thick, and the outer layer is markedly fibrous (FIGURE 28, h). Specimens with the two fruit types are similar vegetatively, and more collections with flowers and ripe fruits are needed to assess the taxonomic significance of the different fruit types. Specimens with a thin stone wall may belong to a taxon close to the *C. pyriforme* complex.

Three specimens from the 4th Division of Sarawak and adjacent Brunei ("a" in the list above) differ from the rest in a number of characters: size of parts, indumentum, and (most obviously) the brown color of the dried twigs and petioles (the characters in which they differ are enclosed in brackets in the description above). One of these specimens (*Hou* 340) has flowers, but the others are sterile; fruits are not known. In characters such as tomentose terminal buds, strongly angled stem, and long-petiolate, coriaceous leaves, the specimens agree with *Calophyllum macrocarpum*, where they are included for the present. However, formal recognition may be necessary when the variation within *C. macrocarpum* is better understood.

Henderson and Wyatt-Smith (*loc. cit.*) considered the record of *Calophyllum macrocarpum* from Singapore (Changi, *Goodenough s.n.*) to be doubtful.

The sheet of *Maingay* 1728 at Kew, collected on July 30, 1867, is designated the lectotype of *Calophyllum macrocarpum*. There is also a sheet under the same number at Kew that was collected on August 3, 1866.

*Calophyllum horstii* agrees in all respects with *C. macrocarpum*; the large fruits that characterize *C. macrocarpum* were mentioned in the protolog. *Calophyllum horstii* is lectotypified on a sheet at Bogor under the number VI C 39; the specimen has fruits. The other specimen cited in the protolog, VI C 42, bears flowers. In the herbarium at Kew there is a specimen labeled *C. horstii* sent by Binnendijk, who initially thought that it might be *C. lowii* (Kew, *Supplementary Foreign Letters 1865-1900*, Volume 218). The local name is given as "benoet" or "bunut," and an excellent drawing of the fruit is attached to the sheet. Van der Horst (Assistant Resident in Sambas, West Kalimantan), after whom the species was later named, seems to have sent the fruit to Binnendijk.

84. *Calophyllum ferrugineum* Ridley, Jour. Straits Branch Roy. Asiatic Soc. 54: 17. 1910. TYPE: Singapore, Rogin, 1900, *Ridley 10842* (lectotype, SING; isoelectotypes, BO, K, P).

Tree 5–30 meters tall, d.b.h. to 48 cm.; trunk without buttresses or spurs; outer bark usually grayish brown to yellow- or green-brown, mottled, with irregular pustules or boat-shaped fissures (rarely blackish and scaly), hoop marked or not, the inner surface brown to blackish (rarely red or yellowish brown) (mottled); under bark red; inner bark reddish; latex usually clear yellow (white or colorless), sticky; sound of soap powder bubbles when cut (*Liew 143*).

Twigs flattened, 1–3 mm. across, obscurely to strongly 4-angled, drying brown (pruinose when young),  $\pm$  persistently tomentose; axillary innovations lacking basal scars; internodes (1–)2–7.5 cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long, erect to spreading; terminal bud plump to stoutly conical, 2.5–7 mm. long, with brown, tomentose to short-tomentose (rarely subcrustaceous) indumentum (hairs, FIGURE 27, j–p), underdeveloped internode to 3(–4.5) mm. long. Petiole 0.8–1.5 cm. long, broadly and often shallowly concave above, convex below, persistently tomentose below or not; lamina oblong to elliptic, (3–)4–12(–15) by 1.1–5(–8) cm., retuse to shortly and bluntly acuminate at apex, acute at base,  $\pm$  undulate and slightly to strongly recurved at margin, coriaceous, drying umber to brick or pale vinaceous-gray above, cinnamon to livid vinaceous below, puberulent and soon glabrescent to subpersistently tomentose on midrib above and below, the midrib above narrowed fairly quickly near base, raised, strongly sulcate at first, adjacent blade obscurely raised, 0.15–0.25 mm. wide at midpoint, below strongly raised, angled to striate, the venation subobscure above, latex canals as prominent as veins, subapparent below, raised, (10 to) 12 to 21 (to 26) veins/5 mm., angle of divergence 50–80°. Inflorescences from foliate axils, with 3 to 13 flowers, usually unbranched (flabellate and/or with 3-flowered branches to 2 cm. long), the axis (1.4–)2–8 cm. long,  $\pm$  tomentose, especially toward base, lowest internode (0.2–)1–5 cm. long; bracts ovate, to 3.5 mm. long, tomentose beneath, deciduous; pedicels 0.5–2 cm. long, glabrous, slender,  $\pm$  incrassate in fruit. Flower (?) hermaphroditic; tepals 4 (rarely 8), the outer pair ovate, 4–6.5 by 3–4 mm., the inner pair obovate-elliptic, 5–7.5 by 4.2–6 mm.; stamens 60 to 140, the filaments to 4.5 mm. long, the anthers oblong, 0.8–1.5 mm. long, slightly retuse at apex; ovary 1–1.8 mm. long, the style 3–4 mm. long, the stigma peltate, 0.6–1.1 mm. across, 3-lobed. Fruit ovoid to ellipsoid, 1.6–2.6 by 1.2–1.6 cm., acute to truncate at apex, drying  $\pm$  cinnamon, sharply wrinkled; outer layer detaching cleanly from stone, 1–1.5 mm. thick, compact, inner surface  $\pm$  shining and striate; stone ovoid to ellipsoid, 1.3–1.7 by 0.8–1.5 cm., rounded to apiculate at apex, the walls 0.1–0.2 mm. thick, smooth, unmarked; spongy layer thin.

#### Key to the Varieties of *Calophyllum ferrugineum*

1. Terminal bud 2.5–4 mm. long; twigs usually not strongly 4-angled; lamina shortly and bluntly acuminate (rarely retuse) at apex. . . . .84b. var. *oblongifolium*.



1. Terminal bud 3.5–7 mm. long; twigs strongly 4-angled; lamina usually retuse to rounded (obtusely pointed) at apex.
2. Lamina slightly recurved at margin, with (10 to) 12 to 19 veins/5 mm.; inflorescence neither branched nor flabellate. . . . . 84a. var. *ferrugineum*.
2. Lamina strongly recurved at margin, with (13 to) 15 to 21 veins/5 mm.; inflorescence often branched and/or flabellate. . . . . 84c. var. *orientale*.

84a. *Calophyllum ferrugineum* Ridley var. *ferrugineum*

*C. ferrugineum* Ridley; Ridley, Fl. Malay Penin. 1: 184. 1922; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 328. 1956; Kochummen, Malayan Forest Rec. ed. 2. 17: 219. 1965; T. C. Whitmore, Fl. Malay Penin. 2: 180. 1973; H. Keng, Gard. Bull. Singapore 28: 244. 1976.

*C. retusum* Wall. ex Choisy, Descr. Guttif. Inde, 41. 1849, Mém. Soc. Phys. Hist. Nat. Genève 12: 421. 1851, *quoad descr. et spec. cit.*; Wall. Catal. 4846. 1831, *nomen*; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 265. 1862; T. Anderson in Hooker f. Fl. Brit. India 1: 272. 1874, *pro parte*; King, Jour. Asiatic Soc. Bengal, II. 59: 176. 1890, *pro parte*; Vesque in C. DC. Monogr. Phanerog. 8: 578. 1893, *pro minore parte*; Ridley, Jour. Straits Branch Roy. Asiatic Soc. 33: 47. 1900, Fl. Malay Penin. 1: 184. 1922; Maheshwari, Bull. Bot. Survey India 2: pl. 21. 1960.

Tree 7.5–22 meters tall, d.b.h. to 43 cm.

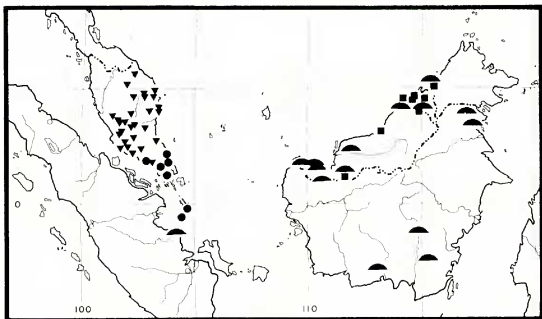
Twigs 2–3 mm. across, strongly 4-angled; terminal bud (3.5–)4.5–7 mm. long. Lamina elliptic to oblong, retuse to obtusely and obscurely pointed at apex, the midrib on lower surface often  $\pm$  persistently tomentose, lacking impressed margins, the veins (10 to) 12 to 19/5 mm., angle of divergence 65–75°. Inflorescences unbranched, lowest internode tomentose; pedicels slightly incrassate. Stamens ca. 70. Fruit acute to rounded at apex.

DISTRIBUTION. Southern Malay Peninsula, Singapore, Lingga Archipelago (Map 29).

SELECTED SPECIMENS SEEN. **Malaya.** JOHORE: Gunong Panti F.R., 427 m., *FRI 1705* (K, KEP, SAN, SING); Mersing, Tenggara F.R., 60 m., *KEP 105163* (K, KEP, SING); Panchor, *KEP 62815* (KEP); G. Pulau, 195 m., *Stevens et al. 100* (A). **Singapore:** Bukit Timah F.R., *SFN 35797* (A, K, KEP, LAE, SING); Botanic Gardens, *Ridley 4799* (BM, SING); Tanjung Gul, *SFN 39641* (E, K, P, SING); Changi, *Ridley 5747* (SING). **Sumatra and adjacent islands.** RIAU: Lingga, Daik, 100 m., *bb 11560* (BO); P. Singkep, Soengei Boeloeh, 20 m., *bb 3946* (BO). **Java.** BARAT: cult. in Hort. Bogor. sub numero *VI C 24a* (BO, K).

ECOLOGY. Lowland or colline mixed dipterocarp forest, in Johore sometimes in seasonally inundated forest; to 425 m. alt. Flowering November and December; fruiting December, January, and April (fruit greenish).

Anthony (1974) reported a midge gall (genus perhaps undescribed; Cecidomyiinae – Cecidomyiidi) that caused the edge of the leaf blade to fold abaxially and thus to form a cylinder ca. 1.5 cm. long. Other midge galls, hemispheric swellings ca. 5 mm. in diameter usually on the abaxial side of the leaf (these



MAP 29. Distribution of *Calophyllum ferrugineum* var. *ferrugineum* (circles), *C. ferrugineum* var. *oblongifolium* (triangles), *C. ferrugineum* var. *orientale* (squares), and *C. hosei* (half-circles) in Malasia.

sometimes becoming confluent, and fused in rows), also occurred on the stem, petiole, and midrib. Another gall, a swelling on both faces of the lamina elongated parallel to the midrib, was also described (Anthony, *loc. cit.*).

**GERMINATION AND YOUNG PLANT.** The radicle probably breaks through the stone to one side of the base. The seedling has two pairs of leaves separated by an internode less than 5 mm. long. Internodes produced during subsequent growth are longer, the young plant is erect, and the terminal bud is functional. (Stevens *et al.* 99, 110.)

84b. *Calophyllum ferrugineum* Ridley var. *oblongifolium* (T. Anderson) P. F. Stevens, comb. nov.

*C. pulcherrimum* Wall. ex Choisy var. *oblongifolium* T. Anderson in Hooker f. Fl. Brit. India 1: 272. 1874; *C. oblongifolium* (T. Anderson) Ridley, Jour. Straits Branch Roy. Asiatic Soc. 82: 170. 1920, Fl. Malay Penin. 1: 184. 1922. TYPE: Malaya, Malacca, 26 Sept., Maingay 1066 [*Kew dist.* 173] (holotype, K; isotypes, A, K, L, P).

*C. neriifolium* Ridley, Jour. Straits Branch Roy. Asiatic Soc. 82: 170. 1920, Fl. Malay Penin. 1: 188. 1922; M. R. Henderson, Gard. Bull. Straits Settl. 4: 224. 1928; *C. ferrugineum* Ridley var. *neriifolium* (Ridley) M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 329. 1956; Kochummen, Malayan Forest Rec. ed. 2. 17: 221. 1965; T. C. Whitmore, Tree Fl. Malaya 2: 180. 1973. TYPE: Malaya, Malacca, Mt. Ophir, 10 Dec. 1892, Ridley 3223 (holotype, SING; isotype, K).

*C. ?kunstleri* auct., non King; Burkill & Haniff, Gard. Bull. Straits Settl.

6: 173. 1930; Burkill, Dict. Econ. Prod. Malay Penin. ed. 2. 1: 416. 1966.

*Calophyllum* sp. Ridley, Jour. Straits Branch Roy. Asiatic Soc. 35: 8. 1901.

Tree 5–30 meters tall, d.b.h. to 48 cm.

Twig 1–2 mm. across,  $\pm$  obscurely 4-angled; terminal bud 2.5–4 mm. long. Lamina elliptic (rarely suboblong), shortly and bluntly acuminate to obtuse (rounded to retuse) at apex, the midrib on both surfaces usually soon glabrescent (rarely subpersistently puberulo-tomentose—e.g., *FRI 14317*), often with impressed margins on lower surface, the veins 11 to 17 (to 26)/5 mm., angle of divergence 50–75°. Inflorescences neither branched nor flabellate, lowest internode short-tomentose; pedicels slightly incrassate. Stamens 60 to 100. Fruit acute (rarely rounded) at apex.

DISTRIBUTION. Central and northeastern Malay Peninsula (MAP 29).

SELECTED SPECIMENS SEEN. **Malaya.** PERAK: Ulu Slim, 120–180 m., *King's collector 10885* (BM, FI, K, L, P); Ulu Bubong, 240–270 m., *King's collector 10929* (BM, BO, FI, G, K, L, US); Behrang F.R., *FRI 1784* (K, KEP, SING). SELANGOR: Sungei Buloh F.R., *KEP 2264* (K, SING); Bukit Lagong F.R., 270 m., *KEP 93374* (A, BO, K, KEP, SING); 18th mile, Pahang Road, 455 m., *FRI 14317* (A, K, KEP, SAN, SING); Gading F.R., Rawang, 549 m., *KEP 94378* (A, KEP); 22½ miles, Kuala Selangor, *KEP 66201* (KEP); Semangkok F.R., 457 m., *KEP 76195* (KEP); Klang Gates, 90 m., *KEP 66609* (KEP); Ulu Gombak F.R., 549 m., *KEP 93291* (BO, KEP, SING); Bukit Lanjan, *Loh s.n.*, 9 Oct. 1972 (KEP). NEGRİ SEMBILAN: G. Angsi, 762 m., *SFN 11655* (A, BO, K, SING); Tampin, *SFN 1379* (BM, BO, K, KEP, SING); Sungei Menyala F.R., *KEP 18503* (KEP); Seremban, Cape Rachado, 120 m., *KEP 70330* (K, KEP); Jelebu, 305 m., *KEP 104916* (K, KEP); Berembun F.R., near Bukit Tangga, *KEP 104862* (K, KEP); Nilai Jindaram Estate, 30 m., *Shah 64* (SING). MALACCA: sine loco, *Alvins 983* (SING). KELANTAN: G. Stong, 838 m., *FRI 10307* (KEP); Ulu Sat F.R., *FRI 2545* (K, KEP, SAR, SING); Sungei Tekal, Gua Ninek, *SFN 19743* (A, BO, SING). TRENGGANU: Bukit Bauk F.R., 270 m., *FRI 2594* (A, K, KEP, SAR, SING); G. Padang Exped., Ulu Brang, 549 m., *FRI 12781* (A, K, KEP, SAN, SING); Kemaman State Land, *KEP 94939* (KEP, SAN, SING); Jerengau F.R., 180 m., *KEP 78561* (KEP); Jambu Bongkok F.R., 6 m., *KEP 77994* (KEP); Mandi Angin, N. of Sungei Loh near Kuala Datok, 427 m., *FRI 12014* (K, KEP); Ulu Dungun, near Sungei Bebir, 270 m., *FRI 9613* (KEP). PAHANG: Ulu Sungei Mentila, Chini, *KEP 2714* (K); Kuantan, Sempedan, 6 m., *KEP 76115* (A, K, KEP, SING); Berserah F.R., 120 m., *KEP 65699* (A, KEP, SING); G. Benom Game Reserve, Ulu Krau, 518 m., *KEP 100102* (A, K, KEP, SING); Ulu Sungei Tekak, 396 m., *KEP 84975* (KEP); Rompin, *KEP 2714* (KEP); G. Tapis, 518 m., *FRI 10037* (KEP); Baloh F.R., *KEP 40213* (KEP); Taman Negara, Lata Bakoh, 240 m., *FRI 23433* (KEP); Kemasul F.R., 75 m., *KEP 78668* (KEP); Temerloh, 180 m., *KEP 77965* (KEP); Bentong, *SFN 16731* (SING). JOHORE: Muar, Banang F.R., *KEP 74110* (KEP).

ECOLOGY. Common in mixed dipterocarp forests on well-drained ridges or hillsides, (6–)100–762 m. alt. Flowering February, May, June, and September (most) to December; fruiting October to May (most in February), June, and July (fruit green, although those of *FRI 20155* reportedly ripen plum color; pericarp eaten by musang (civet cats)).

GERMINATION AND YOUNG PLANT. Details are the same as for *Calophyllum ferrugineum* var. *ferrugineum*. (Stevens et al. 120, FRI 20155.)

LOCAL NAMES AND USES. "Panan belukan"—boiled and the decoction drunk during the first three days after childbirth (Pahang, *SFN* 16731). The wood is used for masts and house-building, and the bark is used in making walls for native homes (Malacca).

The epithet *oblongifolium* ("oblong leaf") is inappropriate for this variety, which has elliptic leaf blades, although *Maingay* 1066 itself has more or less oblong blades.

84c. *Calophyllum ferrugineum* Ridley var. *orientale* P. F. Stevens, var. nov.

*C. ferrugineum* Ridley; Pukol & Ashton, Checklist Brunei Trees, 93. 1964; Smythies, Common Sarawak Trees, 59. pl. 19. 1965; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 15. 1967.

A varietatibus aliis *Calophylli ferruginei* in venatione saepe densiore et inflorescentiis ramosis vel flabellatis differt.

Tree 9–28 meters tall, d.b.h. to 30 cm.

Twigs 2–2.5 mm. across, 4-angled; terminal bud 3.5–7 mm. long. Lamina oblong to subobovate, retuse (rarely obtuse) at apex,  $\pm$  persistently tomentose on midrib on both surfaces, the midrib on lower surface lacking impressed margins, the veins (13 to) 15 to 21/5 mm., angle of divergence 75–80°. Inflorescences often branched or flabellate, lowest internode persistently tomentose; pedicels strongly incrassate in fruit. Stamens 120 to 140. Fruit rounded to truncate at apex.

TYPE: Brunei, Telamba, 29 Oct. 1959, *BRUN* 5696 coll. *Ashton* (holotype, L; isotypes, BO, K, KEP, SAR, SING).

DISTRIBUTION. Northwestern Borneo (Map 29).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 2nd Division: Simanggang, Bukit Manta, 305 m., *S* 6519 (BO, K, L, SAR, SING). 4th Division: Baram, Limbang Road, 30 m., *S* 1500 (KEP, SAR, SING); Tutoh, Melinau, 180 m., *S* 18705 (SAR); Bintulu, Tinggi, *S* 953 coll. *Kerta*, 24 Nov. 1953 (KEP, SAR, SING). 5th Division: Limbang, Sagan Rouge, 427 m., *S* 1104 (SAR). BRUNEI: Telamba, *BRUN* 5697 (BO, K, KEP, L, SAR, SING); Badas F.R., 15 m., *S* 18707 (SAR); Ulu Sugei, 30–60 m., *S* 1003 (K, L). SANDAKAN. Beaufort: Bukit Sunggau, Weston, *SAN* 55655 (L, SAN).

ECOLOGY. Locally common on podzolized soil and in kerangas vegetation, sometimes codominant (*S* 1104, with species of *Casuarina* Adanson and *Dacrydium* Solander); to 427 m. alt. Flowering January, June, July, and October; fruiting in October (fruit white).

The epithet *orientale* ("eastern") was coined because this variety grows to the east of the other two.

*Calophyllum ferrugineum* can be recognized by its tomentose indumentum; its leaf blades, in which the venation on the upper surface appears to be twice as dense as on the lower; and its inflorescences, which have a long (usually 1–5 cm.) basal internode. The flowers have four tepals. The fruits are often ellipsoid and dry wrinkled; the outer layer detaches cleanly from the stone and is shiny on the inner surface. The epithet *ferrugineum* refers to the rust-colored indumentum that is prominent on the buds, the twigs, and the base of the inflorescence.

The ranking of the various infraspecific taxa of—and those related to—*Calophyllum ferrugineum* has been difficult, although the limits of the taxa themselves are fairly clear. All have medium-sized, moderately densely to densely veined leaves, flowers with (usually) four tepals, and fruits that dry wrinkled, with the outer layer detaching cleanly from the stone and shiny and more or less striate on the inner surface. Some of the taxa have wide geographic ranges yet show little variation within this range, although field characters within *C. biflorum* and *C. ferrugineum* var. *oblongifolium* seem to be somewhat more variable. The species in the group have been recognized on a combination of characters of venation type, inflorescence type, and indumentum distribution; thus, *C. ferrugineum* has venation that appears to be twice as dense on the upper surface of the leaf blade as on the lower (the only species in the group with this character), tomentose indumentum (*C. costulatum* approaches this indumentum type), and an inflorescence with the lowest internode very long (as in *C. costulatum*; less so in *C. biflorum*).

The differences separating the varieties of *Calophyllum ferrugineum* from each another and also from the related species *C. sundaicum*, *C. biflorum*, and *C. costulatum* are listed in TABLE 13. Sterile specimens of *C. ferrugineum* var. *oblongifolium* have been confused with those of *C. symingtonianum*, but can be separated by the differences given in TABLE 6.

The three varieties of *Calophyllum ferrugineum* occupy geographically different areas (MAP 29). *Calophyllum sundaicum*, which always or nearly always grows in swampy forest, and *C. ferrugineum* var. *ferrugineum* were found growing together with a variant of *C. costulatum* in the Panti Forest Reserve, South Johore. *Calophyllum ferrugineum* var. *ferrugineum* was found growing with *C. biflorum* on Gunong Pulai, in southern Johore.

The specimens of *Calophyllum ferrugineum* from Malaya and Singapore can be placed in their respective varieties, *ferrugineum* and *oblongifolium*, with little difficulty, although *FRI 14317* (var. *oblongifolium*) has the leaf shape of var. *ferrugineum*. Some of the specimens of *C. ferrugineum* var. *ferrugineum* from Johore have somewhat shorter internodes than the specimens from Singapore, and *KEP 105163* has fruits that are rounded at the apex. Bark characters in the group seem to be fairly variable. The latex of *C. ferrugineum* var. *ferrugineum* is yellow, while that of var. *oblongifolium* is usually white. However, latex in specimens of *C. ferrugineum* var. *oblongifolium* (e.g., the numerous specimens collected in Gunong Stong, Kelantan) is sometimes recorded as yellow; in *FRI 10307* (also Gunong Stong) it is

TABLE 13. Variation of some characters in

	<i>C. biflorum</i> Malaya-Singapore	<i>C. biflorum</i> Borneo	<i>C. ferrugineum</i> var. <i>ferrugineum</i>
TERMINAL BUD			
LENGTH (mm.)	2.5-3.5	3.5-9.5	(3.5-)4.5-7
INDUMENTUM	Short-tomentose	Tomentose (subcrustaceous)	Tomentose
HAIRS WITH LARGE, VERY THICK-WALLED, BIREFRINGENT APICAL CELLS	+ -	+ -	-
TWIGS 4-ANGLED	Obscurely	Strongly to slightly	Strongly
LAMINA			
SHAPE	Oblong (elliptic/ obovate)	Basically oblong	Elliptic to oblong
APEX	Retuse to obtuse	Retuse to obtuse	Retuse to subobtuse
VENATION DENSITY (veins/5 mm.)	8 to 12	(8 to) 9 to 15 (to 18)	(10 to) 12 to 19
LATEX CANALS PROMINENT ON UPPER SURFACE	-	-	+
MARGIN			
RECURVED	-	-	- ±
UNDULATE	-(+)	Slightly	±
FLOWERS USUALLY IN FOURS ALONG INFLORESCENCE AXIS	-	-	-
INDUMENTUM			
PEDICELS	-	-	-
BACKS OF OUTER TEPALS	-	-	-
STAMEN NUMBER	?	60 to 225	Ca. 70
ANTHER LENGTH (mm.)	?	Ca. 1.2	Ca. 1.3
FRUIT			
SHAPE	Short-ellipsoid, apex ± rounded	Short-ellipsoid, apex ± truncate	Long-ellipsoid, apex pointed
SURFACE (when dry)	Coarsely wrinkled	Coarsely wrinkled	Coarsely wrinkled
LATEX COLOR (in trunk)	White	White (clear yellow)	Yellow, clear (rarely colorless)

the *Calophyllum ferrugineum* complex.

<i>C. ferrugineum</i> var. <i>oblongifolium</i>	<i>C. ferrugineum</i> var. <i>orientale</i>	<i>C. sundaicum</i>	<i>C. costulatum</i>
2.5-4 ± Tomentose (rarely subcrustaceous)	3.5-7 Tomentose	5-10 Short-tomentose to subcrustaceous	3.5-5.5 Tomentose
—	+(-)	—	—
Obscurely	Strongly	Moderately	Strongly to slightly
Basically elliptic	Basically oblong	Elliptic to oblong	Elliptic to oblong
Obtuse to subacuminate	± Retuse	Retuse (rounded to subobtuse)	Retuse
11 to 17 +	(13 to) 15 to 21 +	13 to 18 —	10 to 16 —
—	+	—	—, slightly
—±	Rather to strongly	—	—, slightly
—	—	-(+)	+
—	—	—, farinose	Tomentose
—	—	—, sparse-farinose	Tomentose
60 to 100	120 to 140	100 to 170	210 to 260
0.8-1.4	0.9-1.5	1.2-2	0.35-0.5
Long-ellipsoid, apex pointed	Short-ellipsoid, apex ± truncate	Short-ellipsoid, apex rounded	Spherical, apex rounded
Coarsely wrinkled	Coarsely wrinkled	Coarsely wrinkled	Finely wrinkled
White or yellow, clear	Yellow	Yellow, clear	Yellow, almost clear

reported to be aromatic. Little is known about the bark of *C. ferrugineum* var. *orientale*; the latex appears to be at least sometimes yellow, and the bark is sometimes blackish and scaly. The hairs of *C. ferrugineum* var. *orientale* have notably thick-walled and birefringent apical cells; the apical cell walls in the other varieties are often thin, or moderately thick and slightly birefringent (FIGURE 27, o, p).

#### Nomenclatural Confusion in the *Calophyllum* *ferrugineum* Group

There has been much confusion as to the correct names for taxa in the *Calophyllum ferrugineum* group. When Choisy described *C. retusum*, he included *C. burmannii* Wight in its synonymy, hence *C. retusum* Wall. ex Choisy is an illegitimate (superfluous) name now referable to *C. burmannii* (= *C. calaba* var. *bracteatum*). Choisy's description of *C. retusum* seems to be based at least in part on Wallich dist. 4846, the only specimen he cited under *C. retusum* and to which Wallich had earlier given the manuscript name *retusum*. Planchon and Triana (1862) removed *C. burmannii* from the synonymy of *C. retusum*, basing the latter on Wallich dist. 4846 and giving an excellent description of the species. Unfortunately, they were nomenclaturally incorrect in doing this; their species is referred to below as "*C. retusum*."

Unaccountably, Anderson (1874) totally confused the taxa. He included both *Calophyllum amoenum* and *C. pisiferum* in the synonymy of "*C. retusum*," although the description that he gave seems to be based predominantly on *C. pisiferum*. He gave no reasons for doing this, although he may have been influenced by Planchon and Triana's removal of *C. retusum*  $\beta$  [var.] *parvifolium* to synonymy under *C. amoenum* forma  $\beta$ . (*Calophyllum amoenum* is properly a synonym of *C. polyanthum*. The correct name for the "*C. amoenum*" of authors mentioned here is *C. calaba* var. *bracteatum*.) "*Calophyllum amoenum*," *C. pisiferum*, and "*C. retusum*" are unrelated and very distinct species. Pierre (1885) and subsequent workers in the mainland Southeast Asia area have used the name *C. retusum* for what is properly called *C. pisiferum*. Vesque (1889) figured specimens of *C. pisiferum* as "*C. retusum*"; later (1893), and apparently on Anderson's suggestion, he restored "*C. amoenum*," with *C. pisiferum* as a synonym: "c'est sur la foi de M. T. Anderson que j'avais confondu le *C. retusum* avec le *C. amoenum*." However, he cited Helfer 881 ("*C. amoenum*") under "*C. retusum*" and appears to have based his anatomical description of "*C. retusum*" on that specimen. His morphological description of "*C. retusum*," which does not particularly emphasize the prominent indumentum and describes the inflorescence as being only 12–18 mm. long and five- to seven-flowered, reads somewhat like the description of yet another species, *C. sundaicum* (see below).

King (1890) included only *Calophyllum pisiferum* in the synonymy of "*C. retusum*," so when Ridley (1922) removed and correctly circumscribed *C. pisiferum*, he automatically did the same for "*C. retusum*," citing specimens collected by Wallich and Cantley. Ridley also described *C. ferrugineum*, which



he distinguished from "*C. retusum*" by its slightly larger and oblong (rather than obovate) lamina and its considerably larger inflorescence. A duplicate of *Wallich dist.* 4846 at Kew has somewhat smaller inflorescences and terminal bud than are common in "*C. retusum*," but in indumentum distribution and type it is similar to other specimens referred to *C. ferrugineum*; the two taxa are the same, and the correct name for the combined taxon is *C. ferrugineum*.

Perhaps following Vesque (see above) and misled by the appearance of *Wallich dist.* 4846, authors working on the flora of the Malay Peninsula have recently used the name "*Calophyllum retusum*" for the taxon described below as *C. sundaicum*. *Calophyllum sundaicum* has a shorter inflorescence and less conspicuous indumentum than are found in *C. ferrugineum*, and the venation on the upper surface of the leaf blade is the same density as that on the lower.

The synonymy given above for *Calophyllum ferrugineum* and its varieties presents no problems. The name *oblongifolium* must replace the more appropriate *neriifolium* for the most northerly variant of *C. ferrugineum*. The name *C. ferrugineum* itself is here lectotypified by the sheet of *Ridley 10842* at Singapore; *Ridley (loc. cit.)* also cited *Ridley 4799*.

85. *Calophyllum sundaicum* P. F. Stevens, sp. nov.

FIGURE 28, m-o.

*C. retusum* auct., non Wall. ex Choisy; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 331. pl. 15. 1956; J. Anderson, Gard. Bull. Singapore 20: 154. 1963; Kochummen, Malayan Forest Rec. ed. 2. 17: 218. 1965; Smythies, Common Sarawak Trees, 61. 1965, excl. spec. cit.; T. C. Whitmore, Tree Fl. Malaya 2: 188. 1973; H. Keng, Gard. Bull. Singapore 28: 255. 1976; Corner, Gard. Bull. Singapore Suppl. 1: 104. 1978.

A speciebus aliis *Calophylli* in foliis mediocris ellipticis vel oblongis apice plerumque retusis in siccitate marginibus planis nervis lateralibus densis (11 usque ad 18 per 5 mm.), et fructu ellipsoideo strato exteriori rugoso e putamine munde secedenti pagina interiore nitida plus minusve striata, differt.

Tree 22–28 meters tall, d.b.h. to 65 cm.; trunk without buttresses (with loop roots); outer bark brown to yellowish, shallowly and closely fissured, or with lenticels in lines, or cracked, the inner surface dark brown to black; under bark orange-brown to dark straw; inner bark pale to dark red; latex yellow, clear, very sticky.

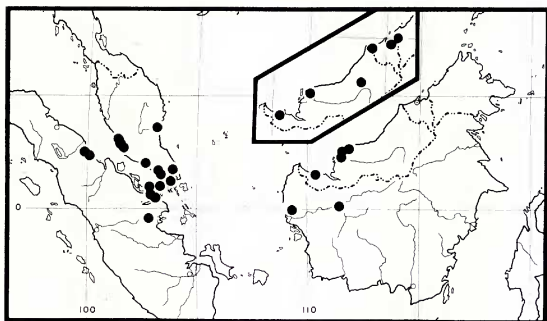
Twigs flattened, (1.5–)2–3 mm. across, 4-angled, drying dark brown to blackish, brown-puberulent when young; axillary innovations lacking basal scars; internodes 0.7–4 cm. long; uppermost pair of axillary buds subrounded, to 3 mm. long, erect; terminal bud plump, 5–10 mm. long, with brown to grayish, puberulent to subtomentose indumentum (hairs, FIGURE 29, c-e), underdeveloped internode to 3 mm. long. Petiole 0.8–2 cm. long, concave to V-shaped above and convex below, ± puberulent when young; lamina elliptic to oblong, (3.2–)4.5–10(–14.5) by 2.5–5.5 cm., ± retuse (rounded to subacute) at apex, cuneate to rounded at base, not undulate to slightly so

and recurved at margin, coriaceous, drying bay to castaneous or dark brick above and  $\pm$  umber below, puberulent on midrib on both surfaces, the midrib above usually narrowing near base,  $\pm$  depressed at first, becoming raised, or raised from base, 0.15–0.3 mm. wide at midpoint, below raised, striate to subangled (edges depressed), the venation subobscure on both surfaces, slightly raised, 11 to 18 veins/5 mm., angle of divergence (50–)70–80°. Inflorescences from foliate axils (rarely terminal—*bb* 4951), with 7 to 11 flowers, unbranched, terminal flowers tending to be 5 together, others in fours, the axis 0.9–2.2(–4) cm. long, puberulent toward base, lowest internode (0.15–) 0.4–1.8 cm. long; bracts ovate, 1.5–2.7 mm. long, not persistent; pedicels ca. 10 mm. long, glabrous to puberulent. Flower (?)hermaphroditic; tepals 4, the outer pair ovate, ca. 6 by 4 mm., rather fleshy, the inner pair  $\pm$  obovate, 7–7.5 by 4.5–6 mm.; stamens 100 to 170, the filaments to 4 mm. long, the anthers oblong, 1.2–2 mm. long, retuse at apex; ovary ca. 1.5 mm. long, the style ca. 3.2 mm. long, the stigma peltate, 1.2–1.6 mm. across, 3-lobed. Fruit ellipsoid, 1.5–2.1 by 1–1.4 cm., rounded at apex, drying brown, pruinose, wrinkled; outer layer detaching cleanly from stone, 0.5–1.3 mm. thick, compact, inner surface shining and striate; stone ellipsoid, 1.3–1.8 by 1–1.2 cm., rounded at apex, the walls 0.15–0.2 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Singapore, Seletar Forest, behind Nee Soon vegetable gardens, 16 June 1951, *SFN* 39252 coll. *Sinclair* (holotype, SING; isotypes, K, KEP, L).

DISTRIBUTION. Southern Malay Peninsula to western Borneo, excluding Java (MAP 30).

SELECTED SPECIMENS SEEN. **Malaya.** SELANGOR: Sungai Tinggi, Kuala Selangor, *SFN* 34087 (A, K, KEP, L, LAE, SING); Klang, Telok F.R., *KEP* 23230 (K, SING); Selatan, *KEP* 96602 (KEP); Kuala Langat, *KEP* 53951 (KEP); Olar Simpit, *KEP* 43692 (KEP). PAHANG: Pekan, State Land, Batu 2 Jalan Kuantan, *KEP* 69601 (KEP); Menchali F.R., *KEP* 67623 (KEP); Kuantan, Pekan–Ninen road, *KEP* 77956 (KEP). JOHORE: Pontian, Api-Api, *KEP* 75603 (BO, K, KEP, L, SING), Pengkalan Raja, *SFN* 36637 (SING); Pontian Besar, *KEP* 70261 (KEP); Kiri Mudek [Sungei Benut], *KEP* 73053 (KEP); Ayer Hitam, *KEP* 70206 (KEP, SING); 8th Mile, Kota Tinggi–Mawai road, *SFN* 29050 (BO, K, KEP, SING); 14 miles Muar–Pt. Sulong road, *KEP* 74107 (KEP). **Singapore:** Jurong, *SFN* 26047 (A, K, KEP, L, LAE, SING); 11½ miles Mandai Road, *SFN* 40268 (A, SING); Botanic Gardens, *SGN* 1633 (?cult.) (SING). **Sumatra and adjacent islands.** RIAU: Karimoen, Telok Sabuk, 1 m., *bb* 5309 (BO), Pangka, 10 m., *bb* 7360 (BO), Tandjong Poendoer, 15 m., *bb* 6306 (BO); Indragirische Bovenlanden, P. Gelang, 4 m., *bb* 29116 (A, BO, K, L, NY, SING); Bengkalis, Poeloe Rangsang, Panglong 222, 3 m., *Begu* 505 (BO, L), Telok Oekis, 3 m., *bb* 12853 (BO), P. Mendal, Keloemang, *bb* 12473 (BO); Selatpandjang, Kampar-monding, 5 m., *bb* 22059 (BO, L); Laboean Batoe, Laboean Bilik, 5–10 m., *bb* 4951 (BO); Soengei Ranah, 5–10 m., *Prunier* 286 (BO). UTARA: Bila, 40 m., *Lörzing* 14227 (BO). **Borneo.** SARAWAK. 1st Division: Setapok F.R., 30 m., *S* 4817 (K, L, SAR, SING); Unjam F.R., 0 m., *S* 14464 (SAR). 3rd Division: Daro F.R., *Si* 126 coll. *Anderson*, Sept. 1953 (SAR); Loba Kabang South Protected Forest, *KEP* 79329 (SAR); Pulau Burit, Sungei Kelepu, 3 m., *S* 8039 (?) (SAR). 4th



MAP 30. Distribution of *Calophyllum sundaicum* in Malaysia. Inset: *C. havilandii*.

Division: Miri, Sungei Dalan F.R., 10 m., *S* 1422 (KEP, SAR). KALIMANTAN. Barat: Soemban, 10 m., *bb* 18386 (A, BO, L); Batoc Lajang, 4 m., *bb* 9675 (?) (BO).

ECOLOGY. Locally common in peat swamps, to 40 m. alt. In Sarawak sometimes in kerangas forest (*S* 1422). Flowering June and September to December; fruiting March and May (fruit greenish).

GERMINATION AND YOUNG PLANT. The radicle probably breaks through the stone to one side of the base. The seedling has two pairs of leaves separated by an internode ca. 5 mm. (–1 cm.) long. Subsequently produced internodes are longer, the terminal bud is functional, and the young plant is erect. (*Stevens et al.* 41.)

*Calophyllum sundaicum* can be recognized by its puberulent indumentum and by its medium-sized, elliptic to oblong leaf blades that are rounded to retuse at the apex, that have rather dense venation above and below, and that have almost flat margins even when dry. The inflorescence axis is fairly short, and the flowers have four tepals and tend to be in groups of four. The fruit is sharply wrinkled, with the outer layer detaching cleanly from the stone; the inner surface of the outer layer is shiny. The places where *C. sundaicum* grows, although now separated by water, were once part of Sundaland, hence the specific epithet.

The characters that separate *Calophyllum sundaicum* from related species are summarized in TABLE 13. The nomenclatural problems surrounding the name *C. retusum*, which has been used for this taxon, are discussed under *C. ferrugineum*.

The inflorescence of *Calophyllum sundaicum* is characteristically short and congested, with the axis less than 2.5 cm. and the lowest internode often less than 1 cm. However, in specimens such as *KEP 75603* (Malaya), and *Si 126* and *S 4817* (Sarawak), the inflorescences are longer and more like those characteristic of *C. ferrugineum*, the basal internode being more than 1 cm. long.

In the herbarium of the Botanic Gardens, Singapore, there is a specimen of *Calophyllum sundaicum* that may have been collected in Malacca. The specimen bears the number "463" and has a local name written in Arabic ("kayo bintangor batu"); the writing is similar to that on some specimens of *C. pisiferum*, also probably collected in Malacca.

86. *Calophyllum costulatum* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 344. pl. 26. 1956; T. C. Whitmore, Tree Fl. Malaya **2**: 173. 1973; H. Keng, Gard. Bull. Singapore **38**: 244. 1976. TYPE: Malaya, Johore, Tanjong Bunga, June 1894, *Ridley 6332* (holotype, SING; isotypes, BM, W).

Tree 5–30 meters tall, d.b.h. to 18 cm.; trunk without buttresses or spurs; outer bark brown to yellowish brown, with vertical rows of flat to pustular lenticels, hoop marked, the inner surface yellow to bright orange; under bark dull reddish; inner bark pale red to pink; latex yellow, slightly opaque or (?)clear, very sticky.

Twigs flattened, 2–3 mm. across, 4-angled, drying blackish to yellowish when young, when older yellowish,  $\pm$  persistently (pale) brown-tomentose; axillary innovations lacking basal scars; internodes 0.5–3.5 cm. long, lowest internode of axillary innovation often notably longer than others, uppermost pair of axillary buds rounded, 2–2.5 mm. long, erect; terminal bud plump, 3.5–5.5 mm. long, with brown, tomentose indumentum (hairs, FIGURE 29, f–i), underdeveloped internode 1–2.5 mm. long. Petiole 2.5–6.5 mm. long, broadly and rather deeply concave above, convex below,  $\pm$  persistently short-tomentose; lamina elliptic to oblong, 2.4–7(–11) by 1.6–3.1(–4.2) cm., retuse at apex, broadly rounded at base, not undulate to slightly so and recurved at margin, coriaceous, drying umber to sepia above (margins much paler) and fulvous to sabelline below,  $\pm$  persistently tomentose on midrib below and often above and on margins, the midrib above narrowing quickly or rather quickly near base, raised, 0.12–2 mm. wide at midpoint, below strongly raised, striate to rounded, venation apparent above, apparent to subobscure below, raised, 10 to 16 veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils (very rarely terminal), with 5 to 11 flowers, terminal flowers often in fives and sevens, others in fours, unbranched, the axis 3.8–9.5 cm. long, tomentose, lowest internode 1.7–5.2 cm. long; bracts unknown; pedicels 1–1.7 cm. long, tomentose. Flower (?)hermaphroditic; tepals 4, the outer pair suborbicular, ca. 4 mm. long and across, backs tomentose-canescens, the inner ones broadly obovate to elliptic, 6–7 by ca. 6 mm.; stamens 210 to 260, the filaments to 4.2 mm. long, the anthers broadly elliptic, 0.35–0.5 mm. long, retuse at apex; ovary ca. 1.2 mm. long, the

style ca. 3.5 mm. long, the stigma peltate, ca. 0.8 mm. across, 2-lobed. Fruit spherical, ca. 1.4 cm. long and across, rounded at apex, drying brown, closely wrinkled; outer layer detaching cleanly from stone, ca. 1.4 mm. thick, compact, striate on inner surface; stone spherical, ca. 1.05 cm. long and across, rounded at apex, the walls ca. 0.25 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Malaya and Singapore (Map 36).

ADDITIONAL SPECIMENS SEEN. **Malaya.** PERAK: G. Besout F.R., Slim R., 90 m., *FRI* 1767 (K, KEP, L, SAN, SING). JOHORE: Kpg. Hubong, Endau, *Kadim & Noor* 371 (A, L, LAE, SING); Panti F.R., Kota Tinggi, 564 m., *KEP* 94367 (K, KEP, L); G. Arong F. R., 15 m., *Stevens et al.* 84 (?) (A). **Singapore:** Bukit Timah, *Langlassé* 123 (G, P).

ECOLOGY. Swamps, flat land, or hillsides, primary and secondary forest; 15–564 m. alt. Flowering June to August (flower scented); fruiting in December (fruit green).

*Calophyllum costulatum* can be recognized by the dense, often whitish, tomentose indumentum on the twig, terminal bud, midrib, inflorescence axis, pedicels, and outer pair of tepals; the oblong-elliptic, usually more or less flat-drying leaf blades with short petioles and clear venation; the flowers with four tepals and small anthers; and the spherical fruits. The specific epithet *costulatum*, the diminutive of *costa* (midrib), refers to the narrow midrib on the upper surface of the lamina.

*Calophyllum costulatum* is clearly related to the *C. ferrugineum* complex; the characters by which it differs are given in TABLE 13. At least sometimes *C. costulatum* has a discolored, pale leaf margin like *C. biflorum*. In the long, lowest internode of the inflorescence, it is like *C. ferrugineum*, and in general fruit structure it agrees with all the members of the complex, although the dried fruit is more finely wrinkled than it is in the other taxa. The hairs of *C. costulatum* are slightly birefringent, and the apical cells, although often very large, are unthickened and empty (hence the whitish color of the indumentum); they are perhaps most similar to the hairs of *C. ferrugineum* vars. *ferrugineum* and *oblongifolium*.

The lamina of *Stevens et al.* 84 dried similar to that of *Calophyllum biflorum*, and the scars of the flowers on the infructescence do not appear to be in fours; it is included in *C. costulatum* only with hesitation. A more problematic specimen is *Soepadmo* 53 (Sumatra, Upper Riau, Pakanbaru, Tonajan River, in swamp; A, B, BO, C, L, NY, SING), which has the very coriaceous lamina and the indumentum distribution of *C. costulatum*, but the lamina is cuneate to acute at the base, the venation is obscure on both surfaces, and the midrib on the lower surface is coarsely striate. There does not seem to be any tendency for the scars of the flowers on the infructescence to be in fours. Both specimens have hairs like those of more typical specimens.

On some duplicates of *Ridley* 6332, the collection date is given as May 7. Whether this is an error or not is unknown.

87. *Calophyllum biflorum* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 349. pl. 29. 1956; Kochummen, Malayan Forest Rec. ed. 2. 17: 217. 1965; T. C. Whitmore, Tree Fl. Malaya 2: 176. 1973; H. Keng, Gard. Bull. Singapore 28: 244. 1976. TYPE: Malaya, Johore, Gunong Arong Forest Reserve, 18 Nov. 1948, KEP 35963 coll. *bin Talib* (holotype, KEP; isotype, K).

*C. retusum* auct., non Wall. ex Choisy; Smythies, Common Sarawak Trees, 61. 1965, *quoad spec. cit.*

*C. inophylloide* King var. *singaporense* auct., non M. R. Henderson & Wyatt-Smith; Smythies, Common Sarawak Trees, 61. pl. 20. 1965, *et quoad spec. cit.*

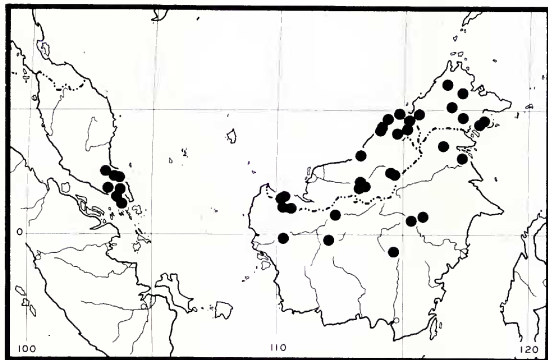
Tree 6–36 meters tall, d.b.h. to 95 cm.; trunk without buttresses (very rarely with spurs); outer bark yellowish and brownish mottled, with distant, shallow, boat-shaped fissures or lines of lenticels and with areas of darker, rougher bark, or brownish, sometimes scaly, often hoop marked, the inner surface mottled orange and dirty brown, to deep brown; under bark reddish; inner bark red, laminated; latex white, often curdy,  $\pm$  sticky (yellow, clear or opaque).

Twigs flattened, 1.2–3(–3.5) mm. across,  $\pm$  4-angled, or rounded, drying (rarely pale) brown or dark brown, transiently farinose to subpersistently tomentose; axillary innovations lacking basal scars; internodes 1–6.5(–7.5) cm. long; uppermost pair of axillary buds  $\pm$  rounded, 0.5–3 mm. long, erect; terminal bud plump to conical, 2.5–9.5 cm. long, usually with brown, tomentose (subcrustaceous, grayish) indumentum (hairs, FIGURE 29, j–l), underdeveloped internode to 3(–7) mm. long. Petiole 0.5–1.8 cm. long, broadly concave above, convex below, glabrescent or subpersistently tomentose; lamina oblong to subelliptic or obovate, 3.5–12.5 by 1.7–4.5 cm., retuse to rounded (rarely subacute) at apex, acute to cuneate at base, slightly to strongly and distantly undulate and barely recurved at margin, coriaceous to very coriaceous, drying grayish sepia to cinnamon above and hazel to sabelline below, with subpersistent, brown, farinose to tomentose indumentum on midrib on both surfaces, or soon glabrescent, the midrib above usually narrowing rather quickly near or gradually from base, raised, 0.15–0.35 mm. wide at midpoint, below raised, striate, the venation apparent (rarely subobscure) above and below,  $\pm$  raised, 7 to 15 (to 18) veins/5 mm., angle of divergence 55–75°. Inflorescences from foliate axils near ends of twigs, with 5 to 21 flowers, sometimes flabellate, and/or with 3-flowered branches to 1.5 cm. long, the axis 0.8–6.5 cm. long,  $\pm$  tomentose on lowest internode, lowest internode (0.2–)0.6–3.2 cm. long; bracts narrowly ovate or elliptic, 2–3 mm. long, deciduous; pedicels 0.8–3.2 cm. long, glabrous, pronouncedly incrassate in fruit or not. Flower (?)hermaphroditic; tepals 4, glabrous, the outer pair ovate to broadly elliptic, 4.5–6 by 3–4.5 mm., the inner pair obovate, ca. 8 by 4 mm.; stamens 60 to 225, the filaments to 3 mm. long, the anthers oblong, ca. 1.2 mm. long, retuse at apex; ovary 1.5–2 mm. long, the style ca. 2.5 mm. long, the stigma peltate, ca. 0.5 mm. across, obscurely 3-radiate. Fruit ellipsoid to spherical or ovoid, 1.1–2.3 by 1.1–2.2 cm., truncate to rounded at apex, drying brownish, sharply

wrinkled (obscurely striate); outer layer detaching cleanly from stone, 0.5–3 mm. thick,  $\pm$  compact, air spaces sometimes developing, the inner surface striate, dull or shiny; stone subspherical to ellipsoid or ovoid, 1–1.8 by 0.8–1.35 cm., rounded to obtusely pointed at apex, the walls 0.1–0.3 (–0.65) mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southern Malay Peninsula, Singapore, Borneo (MAP 31).

SELECTED SPECIMENS SEEN. **Malaya.** JOHORE: Mersing, 30 m., *KEP* 76288 (A, BO, K, KEP, SING, US), Endau Road, 30 m., *KEP* 76281 (A, K, KEP, SING), Ulu Endau, near summit of Bukit Kendek, 396 m., *KEP* 105019 (robust) (A, K, KEP, SING); Kluang, Renggam F.R., 427 m., *KEP* 98951 (A, K, KEP, SAN, SING); Kluang F.R., Bukit Jelakoi, 210 m., *KEP* 76296 (K, KEP, SING); Kota Tinggi, Panti F.R., 90 m., *KEP* 73055 (K, KEP, SING); G. Arong F.R., 45 m., *KEP* 94883 (KEP). **Singapore:** Sungei Hantu, opposite P. Serimbun, 0 m., *SFN* 39532 (A, E, K, KEP, SING); "Woodlands," *Albero s.n.*, March 1866 (FI). **Borneo.** SARAWAK. 1st Division: Semengoh F.R., *Omar* 387 (K, SING); Bako Natl. Park, along Lintang Path, *S* 24865 (K, L, SAR); Sempadi F.R., *S* 6147 (SAR); Matang W. ridge, 305 m., *S* 15241 (A, BO, K, L, SAN, SAR, SING); Serian, G. Penrissen, *S* 16303 (A, BO, K, L, SAN, SAR, SING); Sabal Tapang, 150 m., *Stevens et al.* 177 (A). 3rd Division: Kapit, Yong, Ulu Bediri, 750 m., *S* 36381 (SAR), Ulu Sungei Kapit, Bukit Goran, 750 m., *S* 36187 (SAR), ridge between Sungei Balang and Sg. Balleh, 518 m., *S* 28260 (A, L, SAR, SING); Usun Apau Plateau, R. Jalan, 965 m., *S* 3802 (SAR, SING), between R. Biak and Sut, 721 m., *S* 2938 (SAR, SING, US). 4th Division: Miri, Sungei Miri, *S* 12944 (BO, K, L, SAN, SAR, SING); Baram, Ulu Melinau, 180 m., *S* 1049 coll. *Brunig*, Aug. 1958 (SAR); Bintulu, Nyabau F.R., *S* 14487 (K, L, SAN, SAR, SING); Bukit Lambir,



MAP 31. Distribution of *Calophyllum biflorum* in Malaysia.

366 m., *S* 26780 (A, E, K, SAR, SING). 5th Division: Trusan, Bukit Tudal, 975 m., *S* 8742 (SAR); Lawas, Morigau Range, 1067 m., *S* 18704 (SAR). BRUNEI: Berakas F.R., 15 m., *S* 7811 (A, BO, K, KEP, L, SAR, SING); R. Ingei, 30 m., *BRUN* 131 (A, K, KEP, L, SING); Kuala Belait, *S* 1944 (SAR); Andalau F.R., *BRUN* 251 (BO, K, KEP, L, SAR). SABAH. Sipitang: W. side of G. Lumaku, 16 km. SSE. of Malaman, 1372 m., *SAN* 16718 (?) (BRI, KEP, L, SAN, SING). Ranau: Poring turnoff, 640 m., *Stevens et al.* 558 (A). Labuk & Sugut: Bukit Tangkunan, 180 m., *SAN* 61260 (SAN). Tawau: Tawau R. F.R., 50 m., *SAN* 19449 (L), below summit Mt. Lucia, 1067 m., *SAN* 22691 (BO, KEP, SAN, SAR); Mt. Wullersdorf, 610 m., *SAN* 61428 (SAN); Brassey Range, 770 m., *Stevens et al.* 477 (A). Kinabatangan: Bukit Tingka, 365 m., *SAN* 23268 (?) (KEP); Lamag, S. side of G. Lotung Inarat, 1524 m., *SAN* 83235 (?) (A). KALIMANTAN. Timur: Bulungan, Sg. Sebakis region. *Kostermans* 9247 (BO, K, L, P); Ti-doengsche Landen, 16 m., *bb* 18276 (A, BO, L); Salimbatoe, Sungei Pingping, 150 m., *bb* 11178 (BO); W. Koetai, Mt. Palimasan near Tabang on Belajan R., 800 m., *Kostermans* 12959 (BO, L); Keloempang, 50 m., *bb* 16939 (A, BO, L); Boven Mahakam, Taliba (G. Leng, Bov. Pari), 600 m., *bb* 26586 (BISH, BO, K, L, NY, P, SING). Tengah: Beneden Dajak, Tewai Baroe, 40 m., *bb* 8170 (BO); Poeroktijahoe, Mahoendjoeg, 25 m., *bb* 21247 (?) (A, BO). Barat: foet van G. Kenepai, *Hallier* 1633 (A, BO, BRI, K, L, SING); Melawi Tjatit, B. Kemoenting, 225 m., *bb* 29651 (?) (BO, L, SING); Meliau, Dawak, 50 m., *bb* 12401 (BO).

ECOLOGY. Usually in well-drained mixed dipterocarp forest, to 1067(–1372) m. alt. In Borneo frequently in kerangas vegetation, once in peat swamp (*S* 12944, Sarawak); also in soil derived from ultramafic rock. Flowering May, October, and November; fruiting January to March, May, June, and October (fruit pale green).

GERMINATION AND YOUNG PLANT. The radicle almost certainly breaks the stone to one side of the base. The seedling has two pairs of leaves separated by an internode less than 1 cm. long. Subsequently produced internodes are successively longer, the terminal bud is functional, and the young plant is erect. The leaves of the seedling are 1.1–1.9 cm. wide, and successively produced ones are notably narrower (initially only 0.6–1.3 cm.). Axillary innovations of the young plant may have basal scars. (*KEP* 76296; *Stevens et al.* 50, 134A, 255, 406A.)

LOCAL USES. The wood is used to make planks (Kuching). The latex of *S* 3802 (3rd Division, Sarawak) was noted as being poisonous, but there may have been confusion between this plant and a member of the Anacardiaceae (the local name of *S* 3802 is given as “betaho”).

*Calophyllum biflorum* can be recognized by its usually oblong lamina that has a retuse to subacute apex and venation of equal density on both sides; it often dries with the margin a paler color than the rest of the blade. Its flowers have four tepals, and its fruits are broadly wrinkled when dry. The outer layer of the fruit detaches cleanly from the stone, and the inner surface of the outer layer is striate and usually shiny. Indumentum, other than on the terminal bud, the very base of the inflorescence, and the young parts



of the plant, is usually inconspicuous. The specific epithet *biflorum* means "two flowered"; Henderson and Wyatt-Smith incorrectly thought that this species had two-flowered inflorescences.<sup>15</sup>

There is considerable variation within *Calophyllum biflorum* in Borneo, even in a single locality. On Gunong Matang (near Kuching, Sarawak) at least two forms of the species grow together (*Stevens et al.* 234, a very coriaceous-leaved form, and *Stevens et al.* 237, with less coriaceous leaves—more like the Malayan form). Some specimens from Borneo have yellow latex: *Stevens et al.* 134, from near Kuching, had yellow latex, yet is very close vegetatively to the Malayan form; some of the specimens from the 3rd Division of Sarawak are also reported to have yellow latex. Some Bornean specimens may lack the paler leaf margin otherwise common in the species, and brown outer bark seems to be notably more common in Borneo than in Malaya. In Johore trees of *C. biflorum* often have broad bands or patches of brown, scaly bark from which latex has exuded and dried a more or less pellucid greenish white color; this may be caused by damage to the trunk. I did not observe this phenomenon in trees of *C. biflorum* from Sarawak and Sabah, although there was black dammar at the base of the trunk of *Stevens et al.* 128 (Sarawak). Branched inflorescences are not present in Malayan specimens of *C. biflorum*, although they appear to occur quite commonly in Sarawak and Brunei, and at least sometimes in Sabah (*SAN* 83235). Most Bornean specimens have leaf blades that are more coriaceous and terminal buds that are longer than those of the Malayan specimens. However, the difference is not absolute; *KEP 105019* (Malaya) is very similar to many Bornean specimens.

Despite this considerable variation, it would be imprudent to recognize infraspecific taxa in *Calophyllum biflorum*. The pattern of variation in Borneo is not well understood; not only do distinct forms seem to grow in close proximity (Gunong Matang, Sarawak: see above), but the knowledge of variation in individual characters is imperfect. Thus, in Borneo inflorescence type is known only from a few specimens, and despite the abundance of *C. biflorum* in Johore, Malaya, flowers have still not been collected there. Although there is considerable variation in hair type (FIGURE 29, j-l), the hairs are similar on some Bornean and Malayan specimens.

The specimens cited above from the 3rd Division of Sarawak are included in *Calophyllum biflorum* only with hesitation. Some specimens have large fruits and/or leaf blades that are more or less acute at the apex, and the margin of the leaf does not dry notably discolored. The striate inner surface of the outer layer of the fruit is dull rather than shiny. *S 26780* (4th Division, Sarawak) also has subspherical fruits, the outer layer of which has a dull inner face; this specimen was taken from a large tree reported to have had

<sup>15</sup>The inflorescence of *Calophyllum biflorum* was originally described as being few flowered, while in the key given by Henderson and Wyatt-Smith (*op. cit.*, p. 301) it was called two flowered. However, both the young inflorescences and the infructescences of the material that Henderson and Wyatt-Smith had at hand have or had five to seven flowers.

thick, low buttresses—an unusual condition in the species.

*Calophyllum biflorum* is most closely related to *C. ferrugineum* and its relatives; for the differences separating these taxa, see TABLE 13. Sterile specimens of *C. biflorum* from Borneo, especially from the Semengoh Forest Reserve, near Kuching, Sarawak, can be confused with *C. teysmannii* var. *inophylloide*. The latter taxon has a more or less obovate (rather than oblong) lamina frequently with a clearly thickened margin; although the margin of *C. biflorum* is often discolored, the veins are not obscured by thickening as they are in *C. teysmannii* var. *inophylloide*. *Calophyllum teysmannii* var. *inophylloide* apparently always has yellow latex, and the trunk often has spurs and/or stilt roots; the latex of *C. biflorum* is often white, and spurs and stilt roots are very uncommon. *SAN* 83235 (Sabah) at least superficially approaches *C. canum*: its leaf blades are more or less pointed at the apex and its latex is reported to be "white yellow."

88. *Calophyllum hosei* Ridley, Kew Bull. 1938: 120. 1938; Masamune, Enum. Phanerog. Born. 475. 1942; J. Anderson, Trees Peat Swamp Sarawak, 86. pl. 27B. 1973. TYPE: Sarawak [4th Division], Baram District, Jan. 1895, *Hose* 146 (holotype, K; isotypes, BM, L, SING).

*Calophyllum fragrans* Ridley, Kew Bull. 1938: 120. 1938, *paratype excepto*; Masamune, Enum. Phanerog. Born. 475. 1942. TYPE: Sarawak, 2 miles [3 km.] from Kuching, 10 Dec. 1894, *Haviland & Hose* 3355 (holotype, K; isotypes, A, BM, BO, L, P, SAR, UC, W).

Tree 7.5–18(–36) meters tall, d.b.h. to 45 cm.; trunk without buttresses, small knee roots with prominent, corky lenticels reported (Anderson, *loc. cit.*); outer bark grayish to brown and yellow, often mottled, with lines of lenticels, often hoop marked, the inner surface dark brown; under bark orange-brown; inner bark red; latex yellow (white), opaque to clear, sticky (watery).

Twigs flattened, 1.5–2.5 mm. across, rounded (4-angled), drying blackish brown, glabrous even when young; axillary innovations with pair of basal scars and another pair ca. 1.5 mm. from base; internodes 1–4 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, spreading; terminal bud plump, 1.8–4 mm. long, with short, adpressed, grayish brown indumentum (hairs, FIGURE 25, p, q; some also moruloid), underdeveloped internode 1–4 mm. long. Petiole (0.5–)0.8–1.3 cm. long, broadly concave above, convex below, glabrous; lamina oblong to elliptic, (3–)4–9.5 by (1.7–)2.2–5 cm., retuse (acute-subacuminate) at apex, acute [cuneate] at base, not undulate or shallowly and distantly so and slightly recurved at margin, coriaceous to very coriaceous, drying umber to sabelline-olivaceous above and umber to fulvous-olivaceous below, glabrous, the midrib above gradually narrowed from base,  $\pm$  raised, center sulcate at first, 0.2–0.4 (–0.6) mm. wide at midpoint, sometimes disappearing below apex, below raised, striate [very prominent, rounded], the venation above subobscure, below subobscure to subapparent, slightly raised, (9 to) 11 to 17 (to 22) veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils near ends of twigs, with 7 to 13

flowers, unbranched, the axis 4–8 cm. long, glabrous, lowest internode to 0.3(–2.2) cm. long, ultimate internode often much shorter than penultimate, or terminal flowers 5 together; bracts not seen, probably quite large; pedicels 1–3 cm. long, glabrous, to 2 mm. across at apex in fruit. Flower (?) hermaphroditic; tepals 4, the outer pair suborbicular, 4.5–6(–7) by 4.5–6 mm., deeply concave, thick, the inner pair obovate to broadly elliptic, (5.5–)8–11 by (5–)6.5–9 mm., thinner, less concave or not; stamens 90 to 240 [to 370 to 420], the filaments to 5 mm. long, connate for up to ca. 1.5 mm., the anthers oblong, 0.9–1.5 mm. long, shallowly [to deeply] retuse at apex; ovary 1.3–1.7 mm. long, the style 3–3.7 mm. long, the stigma peltate, 0.7–0.9 [–1.8] mm. across, 2- or 3-radiate. Fruit ovoid to ellipsoid, ca. 1.9 by 1.2 cm., apiculate, drying vinaceous-brown, smooth to shallowly wrinkled; outer layer detaching cleanly from stone, 1–1.2 mm. thick, compact; stone ellipsoid, ca. 1.6 by 1 cm.,  $\pm$  rounded at apex, the walls ca. 0.2 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southeastern Sumatra, Borneo (not in the northeast) (MAP 29).

SELECTED SPECIMENS SEEN. **Sumatra.** DJAMBI: Sampit, 45 m., *bb* 13128 (BO). **Borneo.** SARAWAK. 1st Division: Bako Natl. Park, T. Pandan Kechil, 0–30 m., *Carrick & Enoch* 135 (KLU, SAR); Setapok F.R., 30 m., *S* 8934 (BO, K, L, SAR, SING); Sirak Mangrove F.R., *FA* 1126 coll. *Browne*, 24 Nov. 1951 (SAR); G. Pueh F.R., *S* 6298 (SAR). 2nd Division: Botong Distr., Tj. Keranji, 9 m., *S* 15969 (A, K, SAR, SING). 3rd Division: near Sibu, *Anderson & Ding Hou* 475 (A, BO, C, K, L, SAR, SING). 4th Division: Marudi F.R., 9–15 m., *S* 9971 (SAR). BRUNEI: "Forest Reserve," *FA* 602 coll. *Igan*, 29 March 1935 (KEP). SABAH. Beaufort: Lupak area, 3 m., *SAN* 15861 (KEP, SAN, SAR); Lumak, 24 m., *SAN* 50914 (SAN); Bukit Siungau, 30 m., *SAN* 80634 (K). KALIMANTAN. Timur: Tidoengsche Landen, Sepoetoeck, *bb* 17832 (?) (BO, L); Pembiliangan, 8 m., *bb* 18141 (A, BO). Selatan: Amoentai, Tanupegan, Rantau Kodjang, 10 m., *bb* 7784 (BO); Bulungan, Sebakis R. region, *Kostermans* 9304 (BO, L, SING). Tengah: Sampit, Lei Pemoelian, *bb* 2085 (BO, L); Moera Tewe, Moera Montalat, *bb* 9997 (BO). Barat: Soengei Landak, *Teysmann*, *HB* 11381 (BO, FI, K, L).

ECOLOGY. In freshwater peat swamps, less commonly in kerangas forest; 3–30 m. alt. Flowering November to January and July to September; fruiting in February.

*Calophyllum hosei* can readily be distinguished from other species of the genus by its small terminal bud generally borne on a pronounced underdeveloped internode, by the almost complete absence of hairs except on the terminal bud, by the scars at the base of the axillary innovations, and by the usually short basal internode of the inflorescence coupled with the often much-shortened terminal internode. The fruit is smooth, even when almost mature. The specific epithet commemorates the well-known collector, C. Hose.

The leaves of the saplings of *Calophyllum hosei* are ovate, acuminate at the apex, and up to 16 by 7 cm.

*Calophyllum hosei* is perhaps superficially similar to *C. ferrugineum* and its relatives. However, the characters given above readily separate the two: *C. ferrugineum* and its relatives have a longer terminal bud, much more obvious indumentum, axillary innovations without basal scars, and wrinkled fruits.

In several respects the type specimen of *Calophyllum hosei* (characters enclosed in brackets in the description) differs from the others. It also has a somewhat more coriaceous lamina that is cuneate at the base and has a very prominent, rounded midrib on the lower surface. It is a good match with *S* 8943 (in bud), which was collected from kerangas forest. However, since all specimens cited agree in the other characters noted above, and there are intermediates in the other characters, only one taxon is recognized.

In the original description of *Calophyllum fragrans*, Ridley cited *Haviland* 1812, in addition to the type, *Haviland & Hose* 3355. However, Ridley annotated the former specimen at Kew as being the type, as a note by H. K. Airy Shaw on the specimen indicates that it almost certainly should be. Although the description of the leaves and the position of the inflorescences of *C. fragrans* perhaps agree better with *Haviland* 1812, and O. Stapf's earlier identification of the species as "*C. near retusum*," which Ridley mentions, is on this specimen, the length of the inflorescence and the field notes were apparently taken from *Haviland & Hose* 3355. Hence, Ridley seems to have based his description on both specimens, and his typification as given in the *Kew Bulletin* is followed. *Haviland* 1812 is here included in *C. andersonii*.

89. *Calophyllum cordato-oblongum* Thwaites, Enum. Pl. Zeyl. 407. 1864; Bedd. Fl. Sylvat. 3: xxii. 1871; T. Anderson in Hooker f. Fl. Brit. India 1: 275. 1874; Vesque, Epharmosis 2: tt. 13, 14. 1889; Trimen, Handb. Fl. Ceylon 1: 103. 1893; Vesque in C. DC. Monogr. Phanerog. 8: 562. 1893; Alston in Trimen, Handb. Fl. Ceylon (Suppl.) 6: 21. 1931. TYPE: Ceylon [Sri Lanka], Hinidoon Patoo, Sept. 1863, CP 3823 (isotypes, BM, G, GH, K, L, MEL, NY, P, W).

Tree ca. 20 meters tall, d.b.h. to 40 cm.; trunk apparently without buttresses; outer bark brown to dark red-brown, (shallowly) fissured, the strips 2-3 cm. wide; inner bark red.

Twigs flattened, 2.2-4.5 mm. across, 4-angled, with raised lines decurrent from middle of petiole, drying dark brown, somewhat yellowish when older, sparsely brown-tomentose when young; axillary innovations apparently lacking basal scars; internodes 2-9(-13) cm. long; uppermost pair of axillary buds rounded to pointed, ca. 1.5(-4.5) mm. long,  $\pm$  erect; terminal bud plump, 0.9-1.3 cm. long, with brown, tomentose indumentum (hairs, FIGURE 25, k, t), underdeveloped internode to 1 mm. long. Petiole 3-7 mm. long, concave above, convex below, subpersistently puberulent below or not; lamina oblong to elliptic-oblong, 8-17(-25.5) by 4-7(-11.5) cm., rounded at apex, cordate at base, usually rather distantly undulate and slightly recurved at margin, coriaceous, drying sepia above and cinnamon-sepia below, subpersistently dark brown-puberulent on midrib below, the midrib above abruptly narrowed

at base, depressed for up to half length of leaf, becoming raised, 0.2–0.4 mm. wide at midpoint, below raised, angled, striate toward base, the venation above subobscure to subapparent, below  $\pm$  apparent, raised, (3 or) 4 to 9 veins/5 mm., angle of divergence 60–70°. Inflorescences terminal and from adjacent foliate axils, with 7 to 15 flowers, often flabellate, with 3-flowered branches to 2.5 cm. long, the axis (2–)6–10 cm. long, subsparingly sparsely to densely tomentose, lowest internode (0.5–)1–4 cm. long; bracts unknown; pedicels 0.5–1.3 cm. long, persistently tomentose. Flower (?)hermaphroditic; tepals (6 to) 8, the outer pair orbicular to broadly ovate, 5–7 by 7–9 mm., deeply concave, tomentose on back, the inner ones obovate to narrowly elliptic, 1.2–1.5 by 0.5–1.1 cm., outer two sometimes with few hairs toward base on back; stamens ca. 235, the filaments to 7.5 mm. long, the anthers oblong, 0.8–1.5 mm. long, rounded at apex; ovary 2.5–3 mm. long, the style 7–8.5 mm. long, the stigma peltate, ca. 1.5 mm. across,  $\pm$  3-radiate. Fruit subspherical, 1.7–2.2 by 1.5–2 cm., rounded at apex, drying brown, smooth; outer layer not detaching cleanly from stone, 1.5–2 mm. thick, compact, with few fibers; stone subspherical, to 1.9 cm. long and across, rounded at apex, the walls less than 0.1 mm. thick, smooth, (?)unmarked; spongy layer thin.

DISTRIBUTION. Southwestern Sri Lanka (MAP 8).

SELECTED SPECIMENS SEEN. **Sri Lanka:** Kanneliya forest near Hiniduma, *Kos-termans* 24771 (A, E, US); Galle Distr., Beriliya forest near Elpitiya, *Kos-termans s.n.*, Aug. 1974 (K).

ECOLOGY. Apparently rather uncommon, in rain forest, low elev. Flowering in September; fruiting in May.

*Calophyllum cordato-oblongum* is a distinctive species that can readily be distinguished from the other taxa with cordate lamina bases by its terminal inflorescences with rather persistent, tomentose indumentum; its usually eight-tepaled flowers; and its fruits, which have stones with walls less than 0.1 mm. thick. The epithet refers to the leaf shape: more or less oblong, and cordate at the base.

Although Anderson (*loc. cit.*) described the flowers as having eight petals (i.e., presumably a total of twelve tepals), neither Vesque (1893, *loc. cit.*) nor I have found flowers with more than eight tepals. The surface of the fruit appears to be coarsely furfuraceous, but this is probably caused by damage.

The relationships of *Calophyllum cordato-oblongum* are unclear; its hairs are reminiscent of those of *C. bracteatum*, but the species are otherwise quite dissimilar.

90. *Calophyllum venulosum* Zoll. Syst. Verzeich. 2: 149, 150. 1854. TYPE: Java, ex montosis Seribu, Zollinger 993, *pro parte* (holotype, P).

Tree 4–45 meters tall, d.b.h. to 80 cm.; trunk without buttresses (shortly spurred); outer bark grayish to pale brown, yellowish when young (dark

brown when older), usually cracked and flaking, newly exposed bark darker in color (deeply fissured) (rarely hoop marked), the inner surface dull brown to yellowish (mottled darker); under bark dull straw to reddish, mottled or not; inner bark dark red or pale brown to pink; latex clear (becoming opaque) yellow (brown-yellow or orange-yellow), sticky; sapwood cream; heartwood reddish.

Twigs flattened, 1.5–4.5 mm. across, 6-angled (very strongly flattened and 2-angled) (with transverse raised lines at nodes), drying yellowish or whitish, transiently brown-subfarinose to subpersistently tomentose, hairs to 0.8 mm. long; axillary innovations lacking basal scars; internodes (0.5–)1–10 cm. long; uppermost pair of axillary buds rounded to pointed, to 3.5 mm. long, spreading; terminal bud plump, 3–13 mm. long, with adpressed grayish to spreading brown-tomentose indumentum (hairs, FIGURE 29, o–q, s–u), underdeveloped internode to 3 mm. long. Petiole 1–6 (apparently to 25) mm. long, concave above, convex below, sometimes subpersistently tomentose below; lamina elliptic, ovate, or suboblong to obovate, 3.7–23.5 by 1.2–11.5 cm., acute to rounded (subacuminate) at apex, cordate to auriculate or minutely rounded (narrowly decurrent) at base, deeply and rather distantly undulate but not recurved at margin, the whole lamina  $\pm$  concave, thinly coriaceous to coriaceous, drying bay or honey to brown above and bay or umber to ochraceous below, usually subpersistently farinose to tomentose on midrib below (also above), the midrib above  $\pm$  abruptly narrowed at or near base, at first level or slightly depressed, becoming raised, 0.1–0.4(–0.6) mm. wide at midpoint, below raised,  $\pm$  angled, the venation above subobscure to apparent, below apparent, raised, sometimes clearly branched, 4 to 10 veins/5 mm., angle of divergence 60–80°. Inflorescences from foliate axils (rarely terminal), sometimes two together, with (1 to) 5 (to 11) flowers, very rarely flabellate, unbranched, the axis to 0.5–3.5 cm. long, puberulent to short-tomentose toward base, lowest internode to 0.3–1.7 cm. long; bracts ovate to elliptic, 2.5–5.5 mm. long, caducous; pedicels 0.6–3 cm. long, glabrous, slender, to 4.5 cm. by 2.5(–5) mm. in fruit. Flower (?) hermaphroditic; tepals 4 (very rarely 8), the outer pair ovate, 4–7 by 3.7–5 mm., the inner pair obovate, 7–13 by 4.5–10 mm.; stamens 85 to 205, the filaments to 7 mm. long, connate for up to 0.7 mm., the anthers oblong, 1–1.6(–2.1) mm. long, rounded to subretuse at apex; ovary 1.5–3 mm. long, the style 3–5 mm. long, the stigma peltate, 0.7–1.3 mm. across,  $\pm$  3-lobed. Fruit usually subspherical, 1.2–2 by 1.1–2 cm. (rarely ellipsoid, ca. 2.6 by 2.1 cm.), minutely apiculate, drying dull brown, smooth; outer layer detaching cleanly from stone, 1–4 mm. thick, compact; stone often subobovoid, 0.95–1.25(–1.5) by 0.9–1.1 cm., rounded at apex, the walls 0.1–0.4 mm. thick, smooth, usually with triradiate or biradiate marking at apex; spongy layer thin.

#### Key to the Varieties of *Calophyllum venulosum*

1. Petiole 1–6 mm. long, clearly distinct from lamina; terminal bud 3–13 mm. long. . . . . 90a. var. *venulosum*.
1. Petiole apparently (0.8–)1–2.5 cm. long, not clearly distinct from lamina; terminal bud 3–5 mm. long. . . . . 90b. var. *tenuivenium*.

90a. *Calophyllum venulosum* Miq. var. *venulosum*

- C. venulosum* Miq.; Walp. Ann. Syst. Bot. 4: 366. 1857; Miq. Fl. Indiae Batavae 1(2): 511. 1858; Choisy, Pl. Javan. 9. 1858; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 279. 1862; Vesque, Epharmosis 2: tt. 23, 24. 1889, in C. DC. Monogr. Phanerog. 8: 575. 1893; Koord. & Valetton, Meded. s' Lands Plant. 61(Bijd. Booms. Java 9): 379. 1903; Koord.-Schum. Syst. Verzeich. 1(Fam. 187): 6. 1912; Koord. Exkurs. Java 2: 617. 1912; Merr. Bibl. Enum. Bornean Pl. 394. 1921; Heyne, Nutt. Pl. Indonesië. ed. 3. 1: 1086. 1950; Backer & Bakh. f. Fl. Java 1: 385. 1963.
- C. javanicum* Miq. Pl. Jungh. 3: 292. 1854; Walp. Ann. Bot. Syst. 4: 367. 1857; Miq. Fl. Indiae Batavae 1(2): 510. 1858; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 294. 1862; Keith, N. Borneo Forest Rec. ed. 2. 2: 315. 1952 ("*C. sp. ex aff. javanicum*"); Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 318. 1956, *pro parte*; Kochummen, Malayan Forest Rec. ed. 2. 17: 214. 1965, *pro parte*; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 15. 1967; T. C. Whitmore, Tree Fl. Malaya 2: 187. 1973, *pro parte*. TYPE: Java, m. Gunong-Saribu, *van Gesker s.n.* (holotype, v).
- C. auriculatum* Merr. Philip. Jour. Sci. C. 4: 291. 1909, Enum. Philip. Fl. Pl. 3: 78. 1923. TYPE: Philippine Islands, Mindanao, Zamboanga, Sax River, 500 feet [150 m.], 20 Feb. 1905, *Williams 2339* (isotypes, A, K, NY (several), US).
- C. ijzermannii* Boerl. & Koord. in Koord.-Schum. Syst. Verzeich 2: 39. 1911. TYPE: Sumatra [Tapanoeli], Tapos, 20 Feb. 1891, *Koorders 10331* (holotype, BO).
- C. pulcherrimum* auct., non Wall. ex Choisy; Baker f. Jour. Bot. London 62(Suppl.): 8. 1924.
- C. griffithii* auct., non. T. Anderson; Baker f. *ibid.*

Tree 4-45 meters tall, d.b.h. to 80 cm.

Terminal bud 3-13 mm. long. Petiole 1-6 mm. long; lamina elliptic, ovate, or suboblong to subobovate, 3.7-23.5 by 1.2-11.5 cm., usually cordate or auriculate (rarely acute) at base.

DISTRIBUTION. Malay Peninsula (somewhat doubtful) and Sumatra to the Philippines (MAP 32).

SELECTED SPECIMENS SEEN (letters refer to discussion in text). **Malaya.** PERAK: Kroh F.R., 30 m., *KEP 71909* (KEP). PAHANG: Kemasul F.R., *KEP 78679* (KEP). JOHORE: Bukit Hantu F.R., 60 m., *KEP 79170* (KEP); Pontian, *KEP 70251* (KEP, SING). **Sumatra.** SELATAN: Tandjong-Ning, R. Moesoe-oeloe, 1524-1829 m., *Forbes 2756* (a) (BM, L, MO, SING); Mengkoelem [Mengkulem], 457 m., *Forbes 3069* (a) (A, BM, FL, GH); Rawas, *Grashoff 1122* (e) (BO, L); Moesi Veloe, *Endert 27* (leaf base rounded to acute, ?e) (BO); ond. afd. Redjang, bij Loeboek Bindjai marga Sindang Blibi, 150 m., *bb 3022* (a) (A, BO, L), Loeboek Blingbing, 600 m., *bb 7903* (a) (BO). BARAT: Pajakombo, Deloe Air, 1000 m., *Sjamsoeddin 26* (BO); Sidjoendjoeng, Moearo, 200 m., *bb 2974* (e) (A, BO, L); Padang Lawas, 390 m., *bb 6633* (BO). UTARA: Angkola en Sipirok, Panobasan, 500 m., *bb 26114* (BO, L, MO, SING); Nandsiling c. a., Djoeloe, 1000 m., *bb 6180* (BO); Sibolangit, cult. (seed from Sibajak at 1200 m.), 500 m., *Lörzing 11684* (BO); Langkat, Halaban Keden, 20 m., *bb 8486* (c) (BO).

**Borneo.** SARAWAK. 1st Division: Mattang, *Beccari PB 1988* (c) (FI, K); Kuching, Semengoh F.R., *S 26260* (c) (A, K, L, SAN, SAR, SING); Sabal Tapang, 120 m., *Stevens*, sight record. 3rd Division: R. Biak (R. Luar), 586 m., *S 2974* (c) (L, SAR, SING, US). 4th Division: Mt. Murud, upper Baram, *Moulton 99* (c) (SING). SABAH. Sipitang: Ulu Mendalong, ca. 10 km. SSE. of Malaman, 533 m., *SAN 16763* (c) (BO, BRI, KEP, L, SING). Beaufort: Pangi, 8 km. WNW. of Tenom, 270 m., *SAN 15112* (c) (A, BO, BRI, K, KEP, L, SING). Kota Belud: Mt. Templer F.R., slope of Mt. Madalon, 610 m., *SAN 76223* (?f) (A, SAN, SAR, SING); Tuburan, 305 m., *SAN 3337* (c) (BO, K). Tenom: Rayoh F.R., *SAN 41445* (c) (K, KEP, L, SAN, SAR). Tambunan: Trusmadi F.R., 1524 m., *SAN 31444* (L, SAN). Lahad Datu: Ulu Sungei Segama, 500 m., *Stevens*, sight record. Tawau: Kalabakan, 10 acre plot, Luasong, 15 m., *SAN 59783* (c) (SAN); Brassey Range, 600 m., *Stevens et al. 462* (c) (A). KALIMANTAN. Timur: Salimbatoe. S. Pingping, 150 m., *bb 11171* (BO); Kabiran. S. Bengaloen, 100 m., *bb 11707* (BO); W. Koetai, no. 36, near L. Petah, 500 m., *Endert 3103* (e) (A, BO, K), no. 24, L. Iboet, 150 m., *Endert 4787* (e) (A, BO, K, L); Mt. Maranga on Tundjung Plateau, 200 m., *Kostermans 12250* (f) (BO, CANB, K, L, NY, P, SING); C. Kutei, Belajan R., G. Kelopak near Tabang, 250 m., *Kostermans 10578* (f) (BO, L); peak of Balikpapan, Beoul, 600 m., *Kostermans 7290* (f) (BO); E. Kutei, Sg. Menubar region, 5 m., *Kostermans 5034* (b) (A, BO, K, L, SING); Sangkulirang Distr., Sg. Mandu region, 150 m., *Kostermans 13312* (b) (BO, K, L). Selatan: path from Djaro Dam to Mt. Serempaka, ca. 20 km. NE. of Muara Uja, 680 m., *de Vogel 1071* (f) (L). Barat: Melawi Oeloe, Soengei Semangka, 450 m., *bb 29056* (BO, K, L, NY, SING); Soeka Lanting, *Hallier 160* (?b) (BO). **Philippine Islands.** MINDANAO. Lanao: Kalambugan, *FB 30236*(d)(UC); Lake Lanao, Camp Keithley, *Clemens 1019*(d)(F, G). Zamboanga: Sax R., 150 m., *Williams 2339* (d) (A, K, NY, US). BASILAN: Isabela de Basilan, *Ebalo 884* (d) (A, BISH, E, MO, NY). **Java.** BARAT: Batavia, Pasir Tjihideung, W. v. Leuwiliang en Buitenzorg, 600 m., *Dakkus 180* (between a and b) (BO, L); Bantam, G. Pangisisan (G. Karang), Tjamara, 10–200 m., *Koorders 2884* (a) (BO); Tjioendar, bij Pondok Poelosari (G. Karang), 1050 m., *Koorders 5712* (a) (BO); Baya [Bajah], *Hasskarl s.n.* (a) (L, P); cult. in Hort. Bogor. sub numero *VI C 135* (between a and b) (BO, K, L, P, US).

**ECOLOGY.** Usually in well-drained mixed dipterocarp forest, (5–)200–610 (–1524) m. alt. Sometimes in marshes (*Kostermans 5034*; 5 m. alt.), quite frequently along streams. Flowering January, February, May, July, and September; fruiting January to May, and August to November (fruit yellowish to brownish, acid in taste (*Kostermans 10581*)).

There are spherical galls ca. 1 mm. across on and near the midrib on both surfaces of the leaf on *Dakkus 180*; these are caused by midges (Docters van Leeuwen-Reijnvaan & Docters van Leeuwen, 1926). Raised pustules occur near the margin and the midrib on the lower surface of the leaf in *Koorders 10331*.

**GERMINATION AND YOUNG PLANT.** The seed germinates by breaking the stone to one side of the base (*SAN 16763*). A single seedling seen had a pair of reduced leaves and a pair of expanded leaves (de Vogel, 1980, *pl. 15*). Initially the young plant grows slowly, with internodes less than 3 cm. long and only one pair of leaves being produced per flush; after the plant reaches



ca. 40 cm. in height, growth is more rapid. The plant is erect, and the terminal bud is functional.

LOCAL USE. In Java (Bantam) the wood is used for oars (Heyne, *op. cit.*).

90b. *Calophyllum venulosum* Zoll. var. *tenuivenium* (M. R. Henderson & Wyatt-Smith) P. F. Stevens, comb. et stat. nov.

*C. tenuivenium* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 311, pl. 7. 1956; T. C. Whitmore, Tree Fl. Malaya **2**: 193. 1973; Corner, Gard. Bull. Singapore Suppl. **1**: 105. 1978. TYPE: Malaya, Johore, 8th mile Kota Tinggi-Mawai road, 18 Feb. 1937, *SFN 32274* coll. Corner (holotype, SING; isotypes, A, BO, K, KEP, LAE, NY, P, SING).

Tree ca. 20 meters tall, d.b.h. ca. 30 cm.

Terminal bud 3–5 mm. long. Petiole apparently (0.8–)1–2.5 cm. long; lamina elliptic, (2.6–)6–10 by (0.8–)2–4.5 cm., attenuate at base.

DISTRIBUTION. Known only from southern Malaya (Johore).

SELECTED SPECIMENS SEEN. **Malaya**. JOHORE: Panti F.R., 5 m., *Stevens et al. 115* (A); G. Sumalayang, 305 m., *Chin 602* (KLU).

ECOLOGY. Seasonally inundated or colline forest, 5–305 m. alt. Flowering in February; flower scented.

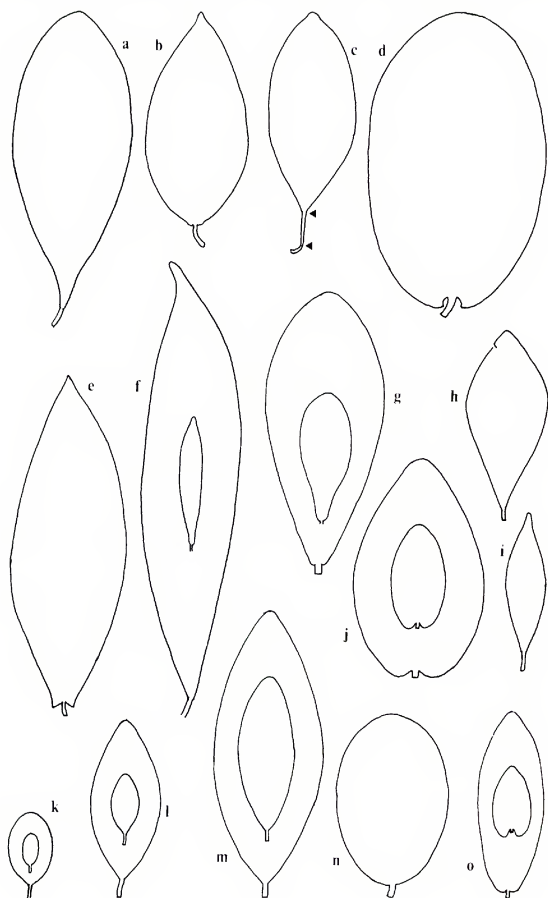
GERMINATION AND YOUNG PLANT. Growth of the young plant is initially slow, with the internodes of plants 20 cm. tall being less than 1(–2) cm. long; growth is erect, and the terminal bud is functional. The stems very soon become yellowish. (*Stevens et al. 116.*)

The epithet *tenuivenium* emphasizes the fine, but distinct and distant, venation on the type specimen.

*Calophyllum venulosum* is usually readily recognizable, despite the variation in its vegetative characters. The twigs dry yellowish white and usually have six raised lines. The leaves often vary considerably in size on a single specimen (FIGURE 30, g); the petiole is short; and the blade is usually cordate to minutely auriculate at the base, often has rather distant venation, and frequently dries bicolored—a dark or grayish brown above and often a somewhat orange-brown below. The inflorescence usually has fewer than seven flowers, and the flowers generally have four tepals. The fruit is characteristic—smooth when dry and with a rather thick outer layer that detaches cleanly from the smooth stone; the stone is nearly always triradiately marked. The epithet *venulosum* refers to the venation, which is often notably apparent and prominent in this species.

#### Rank of *Calophyllum tenuivenium*

*Calophyllum tenuivenium* and *C. venulosum* are similar in all characters except for the apparently long-petiolate leaves of the former: Henderson & Wyatt-Smith (*loc. cit.*) mentioned the petiole of *C. tenuivenium* as usually



being 1–2 cm. long. When dry the petiole is transversely rugulose for ca. the basal 4 mm. only; the remainder dries longitudinally striate. In *C. venulosum* the short petiole dries transversely rugulose, while the midrib on the lower surface of the lamina dries more or less striate. This suggests that the lamina of *C. tenuivenium* is in fact very narrowly attenuate, with the petiole proper being ca. the basal 4 mm. Very young plants of *C. tenuivenium* (Stevens *et al.* 116, collected under an adult tree) have leaves with a short (2.5 mm.) petiole; the lamina is gradually narrowed toward the base and is shortly and abruptly rounded at the very base (FIGURE 30, f). The tree under which these young plants were growing had the “long petioles” normal for *C. tenuivenium*, and it is presumed that in successively produced leaves the lamina becomes more and more strongly narrowed toward the base and is eventually not developed there.

There is a tendency for the base of the lamina to be cuneate or acute in other specimens of *Calophyllum venulosum*, although leaves with blades that are minutely auriculate at the base also occur on these specimens. This tendency is shown by some specimens collected by Forbes from Sumatra (FIGURE 30, a, b), by *Grashoff* 1122 and *Endert* 27 (also from Sumatra), by specimens that are otherwise a good match with the type specimen of *C. ijzermannii* (see below), and by specimens collected by *Endert* (e.g., *Endert* 3451) from West Koetei, Kalimantan. However, in none of these specimens is the petiole more than 7 mm. long, and the petiole and the lamina are always quite clearly separated.

Thus, it seems best to reduce *Calophyllum tenuivenium* to varietal rank under *C. venulosum*. Not only are the leaves of the young plants of *C. tenuivenium* similar to those of *C. venulosum*, but the slow growth of the young plant and the rather distinctive appearance of the bark of the mature tree of *C. tenuivenium* are both similar to those of *C. venulosum* seen in Sabah and Sarawak. Young plants of *Calophyllum venulosum* var. *tenuivenium* have leaves with blades that are acuminate at the apex and up to 15.6 by 5.4 cm.

Variation within *Calophyllum venulosum*  
var. *venulosum*

The type specimens of *Calophyllum javanicum* and of *C. venulosum* are similar and are like a number of specimens from Java and Sumatra (denoted by “a” in the list of specimens examined). The lamina is small to medium sized (less than 14 by 4 cm.), and thin and acute to more or less rounded

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FIGURE 30. Variation in leaf; extent of variation in some collections shown by smaller outlines inside larger ones. a–g, *Calophyllum venulosum*. a, b, d, e, g, var. *venulosum*: a, b, *Forbes* 3189; d, *S* 26277; e, *van Gesker* s.n.; g, *SAN* 15112 (leaves from same shoot). c, f, var. *tenuivenium*: c, *SFN* 32274, arrows mark extent of narrowly attenuate lamina; f, *Stevens et al.* 116 (from very young plant). h–o, *C. pentapetalum*. h, i, k–n, var. *cumingii*: h, i, *BS* 26928; k, *BS* 43260; l, *BS* 44802; m, n, *BS* 30206. j, o, var. *pentapetalum*: j, *Santos* 6178; o, *Cuming* 1212. All  $\times 0.67$ .

at the apex. The petiole is noticeable (3 mm. or more long), and the terminal bud is small (generally less than 5 mm. long). Field characters are scanty for specimens assigned to this group.

A somewhat ill-defined group of specimens from Java and southern Kalimantan ("b" in the list) have leaf blades that tend to dry greenish and subnitid. The apex of the lamina is acuminate, and the short petiole is obscured by the cordate base. In Kalimantan such specimens have been collected from trees 4-28 meters tall.

The form that is most common in Borneo, and which also occurs in Sumatra ("c" in the list), has well-developed, tomentose indumentum on the vegetative parts; the terminal bud is 6-11 mm. long; the twigs are stout (2-4.5 mm. across); the lamina tends to be large, although it is notably variable in size ((3.3-)-6-23.5 by (2-)-3-11.5 cm.); and the base of the lamina is usually clearly cordate or auriculate. Such specimens have been collected from trees 27-42 meters in height.

Specimens from the Philippine Islands ("d" in the list) are similar to those in group c above. However, the indumentum is not well developed except on the terminal bud, where it may be tomentose (e.g., *Ebala* 884) or short and adpressed (e.g., *Williams* 2339). The inflorescence is sometimes rather congested. *Calophyllum auriculatum* was described from a specimen of this type. Specimens have been collected from trees 5-18 meters tall.

Some specimens from Sumatra and southern Kalimantan ("e" in the list) have moderate-sized to large leaves and terminal buds. The lamina is subcoriaceous and dries almost chestnut brown and nitid on the upper surface; the venation density is in the upper range of that given for the species. The type specimen of *C. ijzermannii* is a large-leaved specimen of this type. In both Sumatra and Kalimantan there are apparently independent tendencies for the base of the lamina to become more or less cuneate or acute. Specimens in group e have been taken from trees 12-30 meters tall.

The final group of specimens ("f" in the list), known only from Kalimantan, also have a subcoriaceous, rather densely veined lamina, but it does not dry dark brown and nitid. The terminal bud is ca. 5 mm. long, and the plant does not have very well-developed indumentum. One specimen (*Kostermans* 10581) has mostly ellipsoid fruits up to 2.6 by 2.1 cm.

The specimens from Malaya cited above are included here with hesitation. All are sterile. The specimens from Johore have stout twigs, large leaves, and rather short indumentum on the terminal bud, and are perhaps intermediate between *Calophyllum venulosum* var. *venulosum* group d and *C. subsessile* (q.v.). The specimens from Perak and Pahang have a rather small (4.6-10.6 by 1.6-3.6 cm.) lamina, and their indumentum is well developed; their latex is reported to be yellow or milky yellow. At first sight the latter group of specimens is very distinctive, but more collections of *C. venulosum* and its relatives from the entire Malay Peninsula are needed to assess the significance of the variation discussed above, as well as the status of *C. subsessile*.

Specimens taken from a tree once cultivated at the Botanic Gardens at

Bogor under the number *VI C 133* are atypical in several respects (see also *Calophyllum subsessile*). The inflorescence has up to eleven flowers and is sometimes branched, the flowers have eight tepals, the fruits dry rather deeply and sharply wrinkled, and the stone lacks triradiate markings.

91. *Calophyllum grandiflorum* J. J. Sm. Bull. Jard. Bot. Buitenzorg, III. 1: 396. *tt.* 45, 46. 1920; Backer & Bakh. f. Fl. Java 1: 385. 1965. TYPE: Java, Soekaboemi, G. Tjimerang, ca. 700 m., Jan. 1914, *ten Oever s.n.* (lectotype, BO; isoelectotype, I.).

Tree 15–28 meters tall, d.b.h. to 60 cm.; trunk without buttresses or spurs; outer bark yellowish brown and smooth at first, becoming mid-brown, with vertical lines of lenticellary welts, scaling, scales small, the inner surface yellow-straw; under bark reddish; inner bark dark red; latex opaque yellow, slightly sticky.

Twigs flattened, 3–6 mm. across,  $\pm$  4-angled when young and with prominent raised lines decurrent from each petiole, 2-angled when older (with obscure transverse raised lines at nodes), drying brown (yellowish), glabrous or almost so; axillary innovations lacking basal scars; internodes 4–10 cm. long; uppermost pair of axillary buds acute, up to 7 mm. long, spreading; terminal bud narrowly conical, 1.2–2.2 cm. long, with grayish or brownish, subcrustose indumentum (hairs, FIGURE 25, r), underdeveloped internode to 2 mm. long. Petiole 2–5 mm. long, concave above, angled below, glabrous or puberulent; lamina oblong to elliptic or lingulate, 15–36 by 6–10 cm., acute at apex, cordate at base, undulate and slightly recurved at margin, coriaceous, drying umber to sabelline above and cinnamon to sabelline below, glabrous or with sparse hairs on midrib below when young, the midrib above narrowing quickly near base,  $\pm$  depressed in bottom 3–5(–7) cm., becoming sharply raised, 0.5–0.8 mm. wide at midpoint, below prominent, angled, the venation above and below subapparent to subobscure, raised, 4 to 9 veins/5 mm., angle of divergence 70–85°. Inflorescences from axils of topmost or adjacent leaves, with 3 to 11 flowers, often flabellate (with 3-flowered branches to 3 cm. long), the axis 3–12 cm. long,  $\pm$  glabrous, lowest internode (1–)3–7.5 cm. long; bracts reported to be foliaceous, up to 9.25 by 5.2 cm.; pedicels 3–7.5 cm. long, glabrous, in fruit to 3 mm. thick. Flower (?)hermaphroditic; tepals 8, sometimes glabrous, the outer pair reflexed at anthesis,  $\pm$  orbicular, ca. 11.5 mm. long and across, the inner ones obovate to elliptic, 1.7–2 by 1–1.4 cm.; stamens 320 to 370, the filaments to 8 mm. long, the anthers oblong, 1.5–2.5 mm. long, rounded to retuse at apex; ovary ca. 3.5 mm. long, the style 9–12 mm. long, the stigma peltate, 1.5–2.5 mm. across, 3-radiate. Fruit  $\pm$  spherical to ellipsoid, ca. 2 by 1.5 cm., apiculate, with stipe ca. 2.5 by 4 mm., scars of tepals and androecium prominent, drying yellow-brown, finally dark brown, strongly and sharply wrinkled, furfuraceous; outer layer detaching cleanly from stone, ca. 2 mm. thick, compact; stone spherical to ellipsoid, ca. 1.6 by 1.3 cm., rounded at apex, the walls ca. 0.3 mm. thick, smooth, with 2 to 4 pale longitudinal stripes from apex; spongy layer thin.

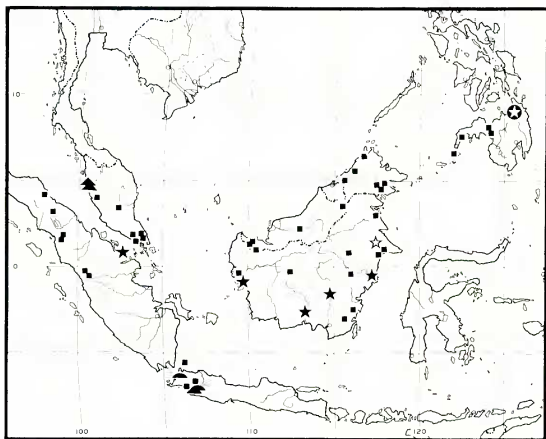
DISTRIBUTION. Western Java (MAP 32).

SELECTED SPECIMENS SEEN. **Java.** BARAT: Lengkong, estate Tjisamporawangum, 600 m., *Kostermans* 23822 (A, AAU, BO, CANB, G, K, L, P), Bodjong Lopang, *Backer* 16990 (BO, L); Bantam, G. Tompok, bij Pasaoeran, 300–400 m., *Backer* 7328 (BO).

ECOLOGY. Locally common in colline forest, 300–700 m. alt. Flowering February, September, October, and November (flower scented); fruiting in January (fruit yellowish brown when ripe).

GERMINATION AND YOUNG PLANT. The radicle breaks the stone wall immediately to one side of the base of the stone. The seedling has a single pair of leaves. Subsequent growth is slow, with the internodes less than 3 cm. long until the plant reaches 20–30 cm. in height; after that the internodes produced are up to 20 cm. long. The terminal bud is functional. (*Stevens et al.* 723.)

*Calophyllum grandiflorum* is one of the most easily recognized species of *Calophyllum*: its large leaf blade is cordate at the base and has relatively distant venation, its terminal bud is long and thin, and its inflorescence has



MAP 32. Distribution of *Calophyllum venulosum* var. *venulosum* (squares), *C. subsessile* (triangles), *C. grandiflorum* (half-circles), *C. mukunense* (solid stars), *C. calcicola* (open star), and *Calophyllum* sp. 95 (star in solid circle) in Malesia.

a long basal internode and large flowers (up to 5 cm. across when fully opened—hence the appropriate specific epithet). The stipitate, strongly wrinkled fruit is also striking.

*Calophyllum grandiflorum* is related to *C. venulosum*: the morphology and bark of the two species are similar, and both have young plants that grow only slowly at first. However, the characteristics mentioned above readily distinguish the two species.

The specimen *ten Oever s.n.* (collected in January, 1914) at Bogor herbarium is made the lectotype of *Calophyllum grandiflorum*. The locality data for this collection are those given on the label; they are slightly different from those given by J. J. Smith (*loc. cit.*). The other specimen that Smith cited, *Backer 7328*, is sterile.

92. *Calophyllum subsessile* King in Ridley, Ann. Bot. Gard. Calcutta 5: 142. *pl. 171*. 1896; Ridley, Fl. Malay Penin. 1: 187. 1922; I. H. Burkill & M. R. Henderson, Gard. Bull. Straits Settl. 3: 347. 1925. SYNTYPES: Malaya, Perak, Larut, less than 100 feet [30 m.], Nov. 1884, *King's collector* [Kunstler] 6877 (BM, K, L, P), less than 100 feet [30 m.], Feb. 1885, *King's collector* [Kunstler] 7311 (K).

*C. javanicum* auct., non Miq.; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 318. 1956, *pro parte*; Kochummen, Malayan Forest Rec. ed. 2. 17: 214. 1965, *pro parte*; T. C. Whitmore, Tree Fl. Malaya 2: 187. 1973, *pro parte*.

Tree to 24 meters tall, d.b.h. to 90 cm.; trunk without buttresses, but knee roots reported; outer bark golden, yellow, green, and brown [mottled], with long, irregular fissures, roughly scaly; under surface yellow; inner bark pale pink, clearly laminated; latex clear golden, sticky.

Twigs slightly flattened, 2–3.5 mm. across, with 6 prominently raised lines, drying  $\pm$  shiny, whitish yellow, initially sparsely brown-puberulent; axillary innovations apparently lacking basal scars; internodes 1.5–4 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, inconspicuous; terminal bud plump, 4–6 mm. long, with grayish brown, farinose-puberulent indumentum (hairs, FIGURE 29, n), underdeveloped internode absent. Petiole 2–3 mm. long, shallowly concave above,  $\pm$  angled below, glabrous; lamina elliptic to oblong, 6.8–14 by 3.7–6 cm., rounded at apex, cordate at base, slightly undulate and not recurved or slightly so at margin, coriaceous, drying amber above and below, glabrous, the midrib above rather quickly narrowed near base, depressed in bottom quarter, becoming raised, 0.2–0.5 mm. wide at midpoint, below raised, angled, the venation above subobscure, below  $\pm$  apparent, raised, 5 to 8 veins/5 mm., angle of divergence 65–75°. Inflorescences terminal and axillary, with 5 to 13 flowers (flabellate and/or with 3-flowered branches to 1.7 cm. long), the axis 5.5–7 cm. or more long, slightly puberulent toward base or not, lowest internode 2–4 cm. long; bracts subelliptic, ca. 5 mm. long, not persistent; pedicels to 1.3 cm. long, glabrous. Flower bud only seen, (?)hermaphroditic; tepals 8, the outer pair suborbicular, to 5 by 4.5 mm.; stamens 155 to 165, the anthers oblong, 1.2–1.7 mm. long, rounded

to subretuse at apex; ovary ca. 1 mm. long, the style ca. 1.5 mm. long, the stigma peltate, ca. 0.7 mm. across, 3-lobed. Fruit spherical, ca. 2.5 cm. long and across, rounded at apex, drying brown, with broad, rounded wrinkles; outer layer detaching cleanly from stone, ca. 2 mm. thick, compact; stone broadly obovoid, ca. 2.1 by 1.9 cm., rounded at apex, the walls ca. 0.4 mm. thick, smooth, with triradial marking at apex; (?)spongy layer thin.

DISTRIBUTION. The Malay Peninsula, known only from Perak (MAP 32).

ADDITIONAL SPECIMEN SEEN. **Malaya.** PERAK: Gelong Raya, 41st mile Bruas-Lumut road, KEP 43570 (KEP).

ECOLOGY. Lowland freshwater swamps or seasonally inundated forests. Flowering in November; fruiting in February.

*Calophyllum subsessile* is closely related to *C. venulosum*, and like that species, it has leaf blades that are more or less rounded at the base and fruits with a thick, compact outer layer that detaches cleanly from the stone; the stone has a triradial marking at the apex. It can be distinguished from *C. venulosum* by its whitish-drying terminal bud, its more coriaceous leaf blades, its longer inflorescences that are sometimes terminal and branched and that have more numerous flowers, its flowers, which have eight tepals, and its larger fruits (spherical fruits of *C. venulosum* are less than 2 cm. long). The almost sessile leaves presumably suggested the epithet *subsessile*.

*Calophyllum subsessile* is provisionally maintained as a distinct species, since the only specimens of *C. venulosum* that have flowers with eight tepals and inflorescences approaching those of *C. subsessile* in size are cultivated specimens from Bogor (VI C 133), which in other characters are unlike *C. subsessile*. The field notes of KEP 43570 report knee roots; although these have not been observed in *C. venulosum*, infraspecific variation in the presence or absence of knee roots is quite common in *Calophyllum*. The distribution of *C. subsessile* in Malaya (MAP 32) is not unexpected for a species with eastern affinities (Keng, 1970).

Saplings of *Calophyllum subsessile* have leaf blades up to 24.5 by 6.5 cm.; the midrib on the upper surface of the blade is raised for its entire length.

The fruits of *Calophyllum subsessile* were reported by King (*loc. cit.*) to be minutely pubescent; they are in fact glabrous.

### 93. *Calophyllum mukunense* P. F. Stevens, sp. nov.

A speciebus aliis Calophylli quibus laminis basibus cordatis et fructibus putaminibus signatis habent in inflorescentiis terminalibus et axillaribus (huius cum internodiis basalibus usque ad 2 mm. longis), floribus cum 8 tepalis, et fructu strato exteriori tenui circa 0.5 mm. crasso, differt.

Tree 18–26 meters tall, d.b.h. to 50 cm.; outer bark yellowish, exfoliating irregularly, the scales elongated, thin, 1 mm. thick; inner bark pink; latex yellow (*Kostermans* 7725).

Twigs strongly flattened, 3.2–5 mm. across, rounded to obscurely 4-angled,



drying yellowish, shiny, glabrous at maturity; axillary innovations apparently lacking basal scars; internodes 1–4.5 cm. long; uppermost pair of axillary buds rounded, to 1 mm. long, inconspicuous, sometimes glabrous; terminal bud broadly conical, 3.5–4.5 mm. long, with brown, crustaceous to subappressed indumentum (hairs, FIGURE 29, m; also moruloid), underdeveloped internode to 2.5 mm. long. Petiole 4–8 mm. long, broadly and shallowly concave above and convex below, glabrous; lamina elliptic to suboblong, 6.3–23.3 by 2.6–7.3 cm., acute to subacuminate (rarely rounded) at apex, cordate to rounded at base, strongly and distantly undulate and slightly recurved at margin, coriaceous, drying shiny, ochraceous to umber above and umber below, glabrous, the midrib above gradually narrowed from base, depressed, (0.25–)0.5–1.1 mm. wide at midpoint, below raised, becoming flat to slightly raised, angled (striate or rounded toward base), the venation usually subobscure above and subapparent below, raised to flat, 4 to 6 veins/5 mm., angle of divergence 65–80°. Infructescences terminal and from adjacent foliate axils, with scars of 11 to 17 flowers, unbranched (rarely with 3-flowered branches to 4 cm. long), the axis 3.5–7.5 cm. long, stout, puberulent at base, lowest internode in axillary inflorescences to 2 mm. long; bracts not known; pedicels 1.3–3 cm. long, glabrous, slender, in fruit to 5.5 cm. by 4 mm. Flower not known. Fruit ellipsoid to spherical, 1.8–2 by 1.4–1.8 cm., rounded at apex, drying grayish brown, strongly wrinkled; outer layer detaching cleanly from stone, ca. 0.5 mm. thick, compact, inner surface shiny; stone subspherical, 1.3–1.7 by 1.2–1.4 cm., rounded at apex, the walls ca. 0.2 mm. thick, smooth, with 3 longitudinal stripes from apex; spongy layer thin.

TYPE: Borneo [Kalimantan], Sg. [Sungei] Mukun near Sangasanga (Samarinda), 5 m., 3 Aug. 1952, *Kostermans* 7725 (holotype, A; isotypes, B, BO, K, L, LAE, P, SING).

DISTRIBUTION. Sumatra and southwestern Borneo (MAP 32).

ADDITIONAL SPECIMENS SEEN. **Sumatra.** RIAU: Selatpandjang, Kampar Monding, 5 m., *bb* 22058 (BO). DJAMBI: Maera Pidjoean, 89 m., *bb* 12831 (BO); Simpang, 45 m., *bb* 13141 (BO). **Borneo.** KALIMANTAN. Tengah: Boentok, Asem, *bb* 2670 (BO); Beneden Djak, Troesas, 1 m., *bb* 9872 (BO); Sampit, Sei Kereng Bindjai, Selongau, 3 m., *bb* 7939 (BO). Barat: Koeboepadi, 5 m., *bb* 6364 (BO).

ECOLOGY. At least periodically flooded forest, 1–90 m. alt. Fruiting March (once), and August (once; submature).

*Calophyllum mukunense* can be recognized by its shiny, at most slightly angled twigs, its rather large leaf blades that are rounded to cordate at the base, its terminal and axillary inflorescences with at least eleven flowers, and its fruits that dry wrinkled and that have an outer layer about 0.5 mm. thick and a triradiately marked stone. The axillary inflorescences have a very short basal internode; however, there do not seem to be scars at the bases of the axillary innovations, although this must be confirmed. The epithet *mukunense* comes from the name of the river near which the type specimen was collected.

The closest relatives of *Calophyllum mukunense* are probably *C. venulosum*, *C. subsessile*, and *C. grandiflorum*, all three of which have similarly shaped leaf blades and stones with triradiate markings. However, the other characters mentioned above readily differentiate *C. mukunense* from these species. Although the pedicels of *C. venulosum* var. *venulosum* are sometimes notably incrassate in fruit (e.g., *Endert* 27, from Sumatra), such specimens agree with *C. venulosum* in all other respects.

94. *Calophyllum calcicola* P. F. Stevens, sp. nov.

FIGURE 28, i.

A speciebus aliis *Calophylli* quibus laminis basibus cordatis habent in innovatione axillari saepe cicatricibus basalibus ornata, lamina mediocra coriacea vel percoriacea nitida, inflorescentiis axillaribus, floribus cum 8 tepalis, et fructu putamine haud signato, differt.

Shrub or tree to 10 meters tall, d.b.h. to 20 cm.; outer bark yellowish, rough, cracked.

Twigs slightly flattened, 1.5–2 mm. across, with 6 elevated lines, drying brown to yellow when young, later whitish, glabrous to sparsely brown-puberulent when young; axillary innovations often with basal scars; internodes 1–5 cm. long; uppermost pair of axillary buds rounded, ca. 0.4 mm. long,  $\pm$  spreading, inconspicuous; terminal bud plump, 2–3 mm. long, with brown, crustaceous indumentum (hairs, FIGURE 25, s), underdeveloped internode absent. Petiole 2–4 mm. long, concave above and convex below, glabrous, drying black; lamina obovate to elliptic-oblong, 1.2–8.5 by 1–3.8 cm., rounded to retuse (rarely apiculate) at apex, auriculate to rounded at base, undulate but not recurved at margin, coriaceous to very coriaceous, drying shiny, bay above and umber below, glabrous, the midrib above abruptly narrowed near base, not obvious, flat to slightly raised, ca. 0.15 mm. wide at midpoint, below raised, striate, the venation subobscure above and apparent below, raised, 4 to 6 veins/5 mm., angle of divergence 40–70°. Inflorescences from foliate axils, with 5 flowers, unbranched, the axis (0.2–)2.5–3.5 cm. long, glabrous or sparsely puberulent at base, lowest internode 0.2–1.5 cm. long; bracts ovate, ca. 2 mm. long, deciduous; pedicels 2–2.7 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8 (rarely 7), sometimes glabrous, the outer pair ovate, ca. 5.5 by 4.5 mm., the inner ones ovate to obovate, 6–8 by 4–5.5 mm.; stamens 60 to 75, the filaments to 3.7 mm. long, the anthers oblong, 1.2–1.6 mm. long,  $\pm$  retuse at apex; ovary 1.5–2 mm. long, the style ca. 2.5 mm. long, the stigma peltate, ca. 0.6 mm. across, (?)lobed. Submature fruit ellipsoid, ca. 1.5 by 1–1.4 cm.,  $\pm$  rounded at apex, drying brown, smooth; outer layer detaching cleanly from stone, ca. 1 mm. thick, compact; stone subspherical, ca. 1.3 by 1.2 cm., almost round at apex, the walls ca. 0.8 mm. thick, smooth, unmarked; spongy layer initially thick.

TYPE: Borneo [Kalimantan], Berouw, Mt. Ilas Bungaan, 700 m., 12 Dec. 1957, *Kostermans* 13837 (holotype, L; isotypes, BO, CANB, K, LAE, P, SING).

DISTRIBUTION. Southeastern Borneo (MAP 32).

ADDITIONAL SPECIMENS SEEN. **Borneo.** KALIMANTAN. Timur: Berouw, Mt. Ilaas Bungaan. 700 m., *Kostermans 13834* (BO, K, L, SING); top of Mt. Ilaas Mapulu, 800 m., *Kostermans 14022* (BO, K, KEP, L, SING).

ECOLOGY. On limestone, 700–800 m. alt.; sometimes shrub pendulous on limestone walls (*Kostermans 13834*). Flowering in September.

*Calophyllum calcicola* can be recognized by its short terminal bud; small, very coriaceous, nitid leaf blades that are rounded to auriculate at the base; axillary, five-flowered inflorescences; flowers with eight tepals; and spherical fruits with an unmarked stone. The epithet *calcicola* means "limestone dweller," a reference to the ecological proclivities of this species.

*Calophyllum calcicola* is perhaps related to the widespread and variable *C. venulosum*. However, it differs in its axillary innovations that often have scars at the base (such scars are absent in *C. venulosum*), its coriaceous and nitid leaf blade, its small terminal bud, its flowers that always have seven or eight tepals (in *C. venulosum* I know of only one cultivated specimen with eight tepals), and its fruit with a thinner outer layer and an unmarked stone. In *C. venulosum* the outer layer is 1–4 mm. thick, and the stone has longitudinal markings.

#### 95. *Calophyllum* sp.

Tree 8 meters tall, d.b.h. 10 cm.; trunk and bark unknown.

Twigs flattened, 2.5–3 mm. across, with  $4 \pm$  raised lines, drying yellowish, tomentose when young; axillary innovations apparently lacking basal scars; internodes (0.3–)0.7–6 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, erect; terminal bud conical, 7.5–8.5 mm. long, brown-tomentose, underdeveloped internode absent. Petiole 2–3.5 mm. long, concave above, convex below, tomentose; lamina elliptic to subobovate or suboblong, 10–20 by 3.8–7.1 cm., cuneate at apex, broadly rounded to shallowly cordate at base, obscurely undulate and slightly recurved at margin, drying near sepia on both surfaces, with grayish covering above,  $\pm$  persistently tomentose over entire lower surface, the midrib above quickly narrowed at base, raised, center strongly sulcate at first, 0.35–0.4 mm. wide at midpoint, below raised, striate, the venation above and below subobscure, raised, 8 to 13 veins/5 mm., angle of divergence 75–80°. Infructescences from foliate axils, with scars of 3 to 5 flowers, unbranched, the axis 2.5–4 mm. long, glabrous when mature, lowest internode 1–2.5 mm. long; bracts unknown; pedicels 8–10 by ca. 2.5 mm., glabrous. Flower unknown. Fruit probably spherical, ca. 2 cm. long and across, minutely apiculate, drying vinaceous-brown, smooth; outer layer detaching  $\pm$  cleanly from stone, 1.5–2.5 mm. thick, compact, small air spaces under skin; stone subspherical, ca. 1.4 by 1.2 cm., rounded at apex, the walls 0.3–0.4 mm. thick, smooth, perhaps with triradiate marking at apex; spongy layer thin.

DISTRIBUTION. The Philippine Islands (MAP 32); known only from a single collection.

SPECIMEN SEEN. **Philippine Islands.** MINDANAO. Agusan: Butuan, San Matea Bo., Tuñgao Bo., along Ojot R., Maasin Line km. 25, 350 m., *PNH 41930* (L, PNH, SING).

ECOLOGY. Colline forest, 350 m. alt. Fruiting in June (fruit green).

LOCAL USE. The wood is used in construction.

*Calophyllum* sp. 95 can be recognized by its bluntly conical, tomentose terminal bud; its rather large, sepia-drying leaf blades that are rounded to shallowly cordate at the base and that have subobscure venation; and its spherical fruits with a thick outer layer and a rather thin-walled stone. Sparsely tomentose indumentum persists on the lower surface of the lamina.

The duplicate of *PNH 41930* at Leiden appears to have furfuraceous fruits, but this is apparently the result of damage.

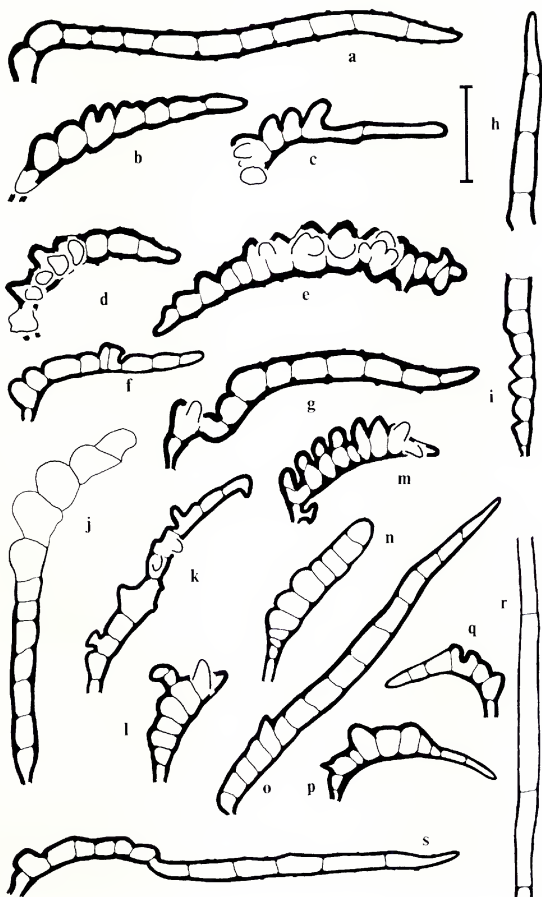
96. *Calophyllum pentapetalum* (Blanco) Merr. Sp. Blancoanae, 266. 1918; *Tovomita pentapetala* Blanco, Fl. Filip. 432. 1837. TYPE: Philippine Islands, Luzon, Lepanto subprovince, *Species Blancoanae 184* coll. *la Peña* (neotype, A; isoneotypes, BO, F, GH, K, L, MO, NSW, NY, P).

Shrub or tree to 7.5 meters tall; trunk and bark unknown.

Twigs not flattened to slightly so, 1–2.3 mm. across, usually strongly 4-angled when young, drying brown to blackish, initially tomentose; axillary innovations lacking basal scars; internodes 0.5–2(–4) cm. long; uppermost pair of axillary buds rounded, to 0.7 mm. long, spreading; terminal bud plump, 1–4 mm. long, with brown,  $\pm$  tomentose to subadpressed indumentum (hairs, FIGURES 29, r, v–x; 31, b, e), underdeveloped internode not apparent. Petiole 0.5–6 mm. long, concave above, convex below, subpersistently tomentose; lamina ovate to oblong or obovate, 1–9.5(–15) by (0.5–)0.9–4.5 cm., acute to rounded at apex, cordate to cuneate at base, neither undulate nor recurved at margin, coriaceous, drying sepia to hazel above and sepia to near sabelline below,  $\pm$  deciduously and sparsely puberulent to tomentose on and near midrib below, the midrib above  $\pm$  quickly narrowed at base, flat to slightly raised (surrounding lamina also raised), 0.2–0.4 mm. wide at midpoint, below slightly raised, subangled to striate, the venation above and below subobscure to subapparent,  $\pm$  raised, 8 to 13 veins/5 mm., angle of divergence (20–)40–75°. Inflorescences terminal and/or from adjacent foliate axils, with 7 to 21 flowers,

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FIGURE 31. Hairs (from terminal bud). a, *Calophyllum clemensorum* (*Clemens & Clemens 40705*). b, c, *C. pentapetalum* var. *pulgarensis*: b, *Foxworthy 567*; c, *Elmer 13217*. d, e, *C. ceriferum*: d, *Robinson 1478*; e, *Poillane 6207*. f, h–k, *C. pisiferum*. f, *SFN 34747* (atypical specimen). h, i, k, *Pierre 3648*: h, i, apex and base of hair ca. 510  $\mu$ m. long; j, *Kostermans 10292*. g, *Calophyllum* sp. 98 (*SAN 21074*). l, r, *C. dispar*: l, *Achmad 1751*; r, *SFN 37715*, base of hair ca. 480  $\mu$ m. long (uncommon type). m, n, q, *C. tetrapterum* var. *tetrapterum*: m, *FRI 14014* (atypical specimen); n, *Kerr 9175*; q, *van Rossum 34*. o, p, *C. rupicola*: o, *Kostermans 22040*; p, *FRI 12526*. s, *C. lineare* (*Martin 1783*). Scale = 120  $\mu$ m.



sometimes flabellate and/or with branches to 4 cm. long and 9 flowers, the axis 3.5–12 cm. long,  $\pm$  tomentose toward base, lowest internode 1–3 cm. long; bracts ovate to elliptic, to 5 mm. long, deciduous (foliaceous, to 3.2 cm. long, subsistent); pedicels 0.7–2.1 cm. long, glabrous or with sparse hairs. Flower (?)hermaphroditic; tepals 6 to 12 (to 17), the outer pair suborbicular, 2.5–5 by 2.2–4.5(–6) mm., the next pair broadly elliptic to obovate, (4–)6–8 by (2–)4.5–6 mm., the inner ones elliptic to obovate, (4–)6–11 by (2–)3–6 mm., sometimes glabrous; stamens 40 to 145 (to 180), the filaments to 6 mm. long, the anthers suboblong, 0.65–1.8 mm. long,  $\pm$  retuse at apex; ovary 1.4–2 mm. long, the style 3–4.8 mm. long, the stigma peltate, 0.7–1.7 mm. across,  $\pm$  3-lobed. Fruit subspherical to ovoid, 8.5–18 by 7.5–10 mm.,  $\pm$  rounded at apex, drying purplish brown to gray, pruinose, smooth, sharply wrinkled when young; outer layer not detaching cleanly from stone, 0.2–0.4 mm. thick, air spaces developing, especially under skin; stone subspherical to ellipsoid, 6–12 by 5–7 mm., rounded at apex, the walls 0.1–0.3 mm. thick, smooth, unmarked; spongy layer thin.

Key to the Varieties of *Calophyllum pentapetalum*

1. Lamina cordate at base; petiole 0.5–2(–4) mm. long. . . . . 96a. var. *pentapetalum*.
1. Lamina rounded to cuneate at base; petiole at least 2 mm. long.
  2. Tepals 12 to 17; stigma at least 1 mm. across; lamina obovate to trapeziform. . . . . 96c. var. *pulgarensis*.
  2. Tepals (6 to) 8 (to 12); stigma less than 1 mm. across; lamina variable in shape, but rarely obovate or trapeziform. . . . 96b. var. *cumingii*.

96a. *Calophyllum pentapetalum* (Blanco) Merr. var. *pentapetalum*

*C. pentapetalum* (Blanco) Merr.: Merr. Enum. Philip. Fl. Pl. 3: 80. 1923.

*Ochrocarpus pentapetalus* (Blanco) Fernand.-Vill. Novis. App. 17. 1880.

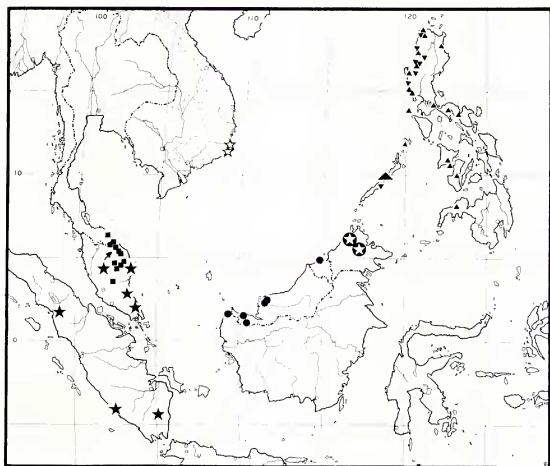
*C. amplexicaule* Choisy ex Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 281. 1862; Vidal, Phanerog. Cuming. Philip. 96. 1885, Rev. Pl. Vasc. Filip. 54. 1886; Vesque, Epharmosis 2: t. 16. 1889, in C. DC. Monogr. Phanerog. 8: 564. 1893; Merr. Philip. Jour. Sci. C. 5: 199. 1910. TYPE: Philippine Islands, Luzon, Albay [properly Ilocos Norte], *Cuming 1212* (holotype, G; isotypes, BM, FI, K, MEL).

Shrub or small tree to 5 meters tall, d.b.h. to 15 cm.

Petiole 0.5–2 mm. long; lamina ovate or elliptic to oblong, 1.1–5.8(–8) by 0.9–3.3 cm.,  $\pm$  cordate at base, angle of divergence of venation 60–75°. Flower with 6 to 12 tepals, outer pair 3.2–5 by 2.9–4.2 mm.; stigma 0.6–0.9 mm. across.

DISTRIBUTION. Philippine Islands: Palawan and western Luzon (MAP 33).

SELECTED SPECIMENS SEEN. **Philippine Islands.** PALAWAN: km. 112, Pinagbatuan, *PNH 91186* (L, PNH). LUZON, Ilocos Norte: sine loco, *Cuming 1841* (K). Ilocos Sur: Candon, *Clemens 18675* (BO, C, SING, UC, W). La Union: San Fernando, *Species Blancoanae 969* (A, BM, BO, F, GH, L, MO, NSW, NY, P, US, W). Benguet:



MAP 33. Distribution of *Calophyllum ceriferum* (open stars), *C. rupicola* (squares), *C. rupicola* variant (solid stars), *C. andersonii* (circles), *C. clemensorum* (stars in solid circles), *C. pentapetalum* var. *pulgarense* (large triangle), *C. pentapetalum* var. *pentapetalum* (inverted small triangles), and *C. pentapetalum* var. *cumingii* (erect small triangles) in Southeast Asia-Malesia.

sine loco, *Loher* 67 (κ). Pangasinan: sine loco, *FB* 28413 (λ). Zambales: Santa Cruz, Barrio Dinabag, *Santos* 6176 (L, US).

**ECOLOGY.** Dry forests, sometimes with pine; also in secondary forest and in rocky places in littoral forest; low alt. Flowering December, February, and March; fruiting November, December, and March.

96b. *Calophyllum pentapetalum* (Blanco) Merr. var. *cumingii* (Planchon & Triana) P. F. Stevens, comb. et stat. nov.

*C. cumingii* Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 259. 1862; Vidal, Phanerog. Cuming. Philip. 96. 1885, Rev. Vasc. Pl. Filip. 54. 1886; Merr. Enum. Philip. Fl. Pl. 3: 78. 1923. TYPE: Philippine Islands, Luzon, Albay [or Zambales?], *Cuming* 1077 (holotype, G; isotypes, BM, E, FI, G, K, L, MEL, NY, P, W).

*C. pseudotacamahaca* Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 270. 1862; Vidal, Phanerog. Cuming. Philip. 96. 1885, Rev. Pl. Vasc.

Filip. 54. 1886; Vesque, *Epharmosis* 2: *tt.* 16–18. 1889, in C. DC. Monogr. Phanerog. 8: 565. 1893. TYPE: Philippine Islands, Luzon, Albay [or Zambales?], *Cuming* 1047 (holotype, G; isotypes, BM, E, FI, G, K, L, MEL, MO, NY, P, W).

*C. buxifolium* Vesque, *Epharmosis* 2: *tt.* 18, 19. 1889, in C. DC. Monogr. Phanerog. 8: 538. 1893; Merr. Enum. Philip. Fl. Pl. 3: 78. 1923. TYPE: Philippine Islands, anno 1853, *Llanos s.n.* (holotype, G).

*C. tacamahaca* auct., non Willd.; Choisy, Descr. Guttif. Inde, 43. 1849, Mém. Soc. Phys. Hist. Nat. Genève 12: 423. 1851, *pro parte*.

Tree 1–7.5 meters tall, d.b.h. to 10 cm.

Petiole 2–6 mm. long; lamina elliptic to obovate, (1–)2–9.5(–15) by (0.5–)1–4.5 cm., cuneate to rounded at base, angle of divergence of venation (20–)40–70°. Flower with 8 or 9 tepals, outer pair 3.5–5.5 by 3–3.5 mm.; stigma 0.4–0.8 mm. across.

DISTRIBUTION. Philippine Islands (MAP 33).

SELECTED SPECIMENS SEEN (for explanation of letter, see discussion). **Philippine Islands.** CALAMIAN. Culion: sine loco, *Merrill* 609 (GH, K, NY, US). MINDORO: Golo, Lubang Is., *PNH* 36738 (cf. a) (K, BISH, L, PNH, SING). LUZON. Ilocos Norte: Burgos, *BS* 26728 (A, K, US); Banguì, *BS* 27419 (A, BO). Ilocos Sur: Barrio Lugong, Santa Maria and vicinity, *Clemens* 17096 (UC). La Union: San Fernandes, 4 m., *Sete* 174 (UC). Pangasinan: So. Cabalatinawan, Sual, 450 m., *FB* 30206 (E, UC). Zambales: Mt. Canaynayan, Castillejos, *BS* 26838 (A, BM, BO, F, L, MO, P, UC, US); Mt. Marayep, 396 m., *BS* 44802 (A, NY, UC); Subig, *Merrill* 1768 (US); Sitio Apulul, Barrio Amungan, Iba, *Santos* 6142 (L, US); Botolan, *Merrill* 2592 (SING, US); Anuling, *BS* 44602 (B, C, NY, UC); Mt. Tapalao, 917 m., *BS* 44718 (L, NY, UC). Quezon: Quinayangan, *Vidal* 1152 (a) (FI, K, L); Gumihan, *FB* 30741 (NY, SING). GUIMARAS Is.: sine loco, *FB* 229 (cf. a) (BM, BO, F, K, LY, NSW, NY, SING, US). PANAY: Iloilo, *FB* 25433 (A, BO, BISH). MINDANAO. Zamboanga: sine loco, *FB* 25284 (A, P, US).

ECOLOGY. Habitats similar to those of var. *pentapetalum*, to 450 (rarely to 917) m. alt. Flowering November to March, and May; fruiting December to March, May, and August (ripe fruit black (*BS* 44602)).

The epithet commemorates H. Cuming, the noted collector of shells, plants, and other items of natural history.

96c. *Calophyllum pentapetalum* (Blanco) Merr. var. *pulgarensis* (Elmer) P. F. Stevens, comb. et stat. nov.

*C. pulgarensis* Elmer, Leaflet Philip. Bot. 5: 1786. 1913 (“*C. pulgarensis*”); Merr. Enum. Philip. Fl. Pl. 3: 80. 1923. TYPE: Philippine Islands, Palawan, Puerto Princesa (Mt. Pulgar), 4250 feet [1295 m.], May 1911, *Elmer* 13217 (neotype, A; isoneotypes, BISH, BM, BO, E, F, FI, G, GH, K, L, LY, MO, NSW, NY, P, U, US, W).

Tree ca. 3 meters tall.

Petiole 2.5–5 mm. long; lamina obovate to trapeziform, 2.1–5.5 by 1.3–3 cm., cuneate at base, angle of divergence of venation 40–55°. Flower with 12 to 17 tepals, outer pair to 5 by 6 mm.; stigma 1.4–1.7 mm. across.



DISTRIBUTION. Philippine Islands, known only from Palawan (MAP 33).

SELECTED SPECIMEN SEEN. **Philippine Islands.** PALAWAN: sine loco, BS 567 (BO, GH, K, SING, NY, US).

ECOLOGY. Locally abundant in rocky, mossy summit scrub, 1100–1300 m. alt. Flowering in May; fruiting in December.

The epithet is taken from the name of the mountain on which the type specimen was collected.

*Calophyllum pentapetalum* can be recognized by its usually rather small and coriaceous leaf blades that often dry sepia-brown and nitid on the upper surface and that have moderately dense venation. The terminal bud is small, with more or less well-developed, tomentose indumentum. The inflorescences are usually terminal, and the flowers are relatively large (often more than 1 cm. across) for the size of the fruit (usually less than 1.5 cm. long). The very thin outer layer of the fruit becomes disorganized by air spaces, and the stone has thin walls. The epithet *pentapetalum* ("five-petaled") was coined because Blanco thought that the specimen he studied had five "petals."

#### Variation within *Calophyllum pentapetalum*

There is a great deal of variation in *Calophyllum pentapetalum*; leaf shape, in particular, varies considerably on a single individual (FIGURE 30, h–o). Despite the (at first sight) very different appearance of the extreme forms, Vesque already suspected in 1893 that the details of lamina anatomy and indumentum of the three species he recognized were so similar that specific rank would probably not be maintained; however, "il faudrait avoir le courage d'opérer la fusion et de distinguer simplement des variétés." Vesque recognized *C. pseudotacamahaca*, *C. buxifolium* (both = *C. pentapetalum* var. *cumingii*), and *C. amplexicaule* (= *C. pentapetalum* var. *pentapetalum*).

Although most specimens of *Calophyllum pentapetalum* from low altitudes in the Philippine Islands are easily placed in either var. *pentapetalum*, which has a lamina that is cordate at the base, or var. *cumingii*, which has a lamina that is cuneate at the base, there are two specimens that are more or less intermediate: BS 30047 (Luzon, Pangasinan, Mt. San Isidro) and PNH 92450 (Luzon, Laguna, Llavac). A few specimens of *C. pentapetalum* var. *cumingii* ("a" in the list above) have somewhat denser venation (10 to 13 veins/5 mm.) that diverges from the midrib at only 20–40°; the apex of the leaf is more acute than usual. In leaf shape such specimens approach the type of *C. buxifolium*. Finally, FB 27842 has long, narrow leaf blades (9–15.5 by 2.5–3.2 cm.), although in other respects it is not unusual.

Although specimens referable to *Calophyllum buxifolium* have very small leaves and at first sight appear to represent yet another variety, *C. buxifolium* and *C. pentapetalum* var. *cumingii* are connected by intermediates. FB 26728, FB 27419, and BS 26838 form a series in leaf size: the first two (from Ilocos Norte Province, Luzon) are placed in *C. buxifolium*, while FB 26838 at the Arnold Arboretum (Zambales, Luzon) has one shoot somewhat like a comparatively large-leaved *C. buxifolium* and the other like a fairly small-leaved

*C. pentapetalum* var. *cumingii* (see also FIGURE 30, h-o). The type specimen of *C. buxifolium*, *Llanos s.n.*, has narrower leaves; the lamina was described as 1.6-3.2 by 0.5-1 cm., although on the type specimen at Geneva the largest leaf remaining is only 2.6 by 1 cm. It is therefore not possible to recognize a taxon based on *C. buxifolium*.

*Calophyllum pentapetalum* var. *pulgarens* grows at higher altitudes than do the other varieties (ca. 1300 m. vs. usually less than 450 (rarely to 917) m.) and is known only from Mt. Pulgar, on Palawan Island; not surprisingly, its leaves are more coriaceous than those of the other two varieties. In these varieties the midrib on the lower surface of the lamina is often demarcated from the adjacent surface by a line that is absent in var. *pulgarens*. *Calophyllum pentapetalum* var. *pulgarens* always has numerous tepals in each flower (vs. usually only eight in the other varieties), and its stigma is very much larger. In all other details, including those of the fruit (in an envelope on the sheet of *FB 3873* at Kew), it is similar to the other two varieties.

#### Nomenclature and Synonymy

I follow Merrill in his interpretation of Blanco's name *Tovomita pentapetala* (Merrill, 1918, *loc. cit.*), and the duplicate of *Species Blancoanae* 184 at the Arnold Arboretum is designated the neotype of the name (Blanco's description is poor).

The type specimen of *Calophyllum pseudotacamahaca*, *Cuming 1047*, has especially well-developed, leaflike bracts, but similar bracts occur in *C. pentapetalum* vars. *pentapetalum* and *cumingii* (the sheet of *Cuming 1047* at FI is exceptional in that the flowers are single and axillary). Planchon and Triana specifically excluded the fruiting shoot of *Cuming 1047* at G from their *C. pseudotacamahaca* because they thought that the small fruits on this shoot were unlikely to have come from flowers the size of those on the other shoot. However, as Vesque (1893, *loc. cit.*) suggested, the two are conspecific. (The localities for the specimens collected by Cuming are taken from Merrill, 1915.)

*Cuming 1077*, the type specimen of *Calophyllum cumingii*, is very similar to the type of *C. pseudotacamahaca*, although it has smaller flowers. It may be noted that if the taxon here called *C. pentapetalum* var. *cumingii* is recognized at the specific level and includes *C. pseudotacamahaca* in its circumscription, the correct name for this taxon is *C. pseudotacamahaca* rather than *C. cumingii* (cf. Merrill, 1923, *loc. cit.*). Vesque (1893, *loc. cit.*) reduced *C. cumingii* to synonymy under *C. pseudotacamahaca*.

The specimen of *Elmer 13217* at the Arnold Arboretum is designated the neotype of *Calophyllum pulgarens*; the holotype was destroyed.

#### 97. *Calophyllum ceriferum* Gagnep. ex P. F. Stevens

FIGURE 28, d-f.

*C. ceriferum* Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 272, fig. 24, 1-8. 1943; Phạm, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. 2: 301, fig. 1970. *Nomen invalidum*.

A *Calophyllo* pentapetalo, quo aliter simile est, in indumento minus evoluto, internodio terminali innovationis saepe brevior quam aliis, pedicellis in fructo valde incrassatis usque ad 2.5 mm. in transversis (minus quam 1 mm. in transversis), et fructibus corrugatis strato exteriori circa 1 mm. crasso, compacto (minus quam 0.3 mm. crasso, haud compacto) et putamine parietibus circa 0.7 mm. crassis (minus quam 0.3 mm. crassis), differt.

Tree 5–12 meters tall; trunk and bark not known.

Twigs flattened, 1.2–1.6 mm. thick, 4-angled, drying blackish (with grayish, waxy covering), puberulent when young; axillary innovations lacking basal scars; internodes 0.4–3.3 cm. long, terminal internode often shorter than others; uppermost pair of axillary buds rounded, ca. 0.5 mm. long, subspreading; terminal bud plump, 1.3–2 mm. long, with short-tomentose brown or grayish subadpressed indumentum (hairs, FIGURE 31, d, e), underdeveloped internode absent. Petiole 0.25–1.3 cm. long, broadly concave above and convex below, glabrous; lamina obovate (rarely subelliptic or trapeziform), (1.6–)2.3–5.5 by (0.6–)1–3.5 cm., obtuse to rounded (rarely subacute to retuse) at apex, cuneate to acute at base, neither undulate nor recurved at margin, coriaceous, drying umber above (color obscured by grayish covering) and below, glabrous or transiently puberulent on midrib below, the midrib above gradually narrowed from base,  $\pm$  flat, 0.1–0.25 mm. wide at midpoint, below raised, rounded, narrow, inconspicuous, the venation subapparent on both surfaces, raised, 5 to 8 (to 10) veins/5 mm., angle of divergence 30–55°. Inflorescences terminal and from adjacent foliate axils, with 7 to 15 flowers, flabellate or with 5-flowered branches to 5 cm. long, the axis 3–7 cm. long, puberulent, or with scattered hairs toward base, lowest internode (0.5–)1.5–4 cm. long; bracts not known; pedicels 0.5–3.1 cm. long, glabrous to transiently puberulent, slender, up to 2.5 mm. thick in fruit. Flower (?) hermaphroditic; tepals 8, the outer pair ovate, 5–6 by 3.5–5 mm., the inner ones elliptic to obovate, 5.5–10 by 3.5–6 mm.; stamens 100 to 125, the filaments to 5 mm. long, the anthers oblong, 1–1.5 mm. long, subretuse at apex; ovary 1.7–2 mm. long, the style ca. 3 mm. long, the stigma peltate, ca. 1 mm. across, 3-radiate. Submature fruit spherical, ca. 1.7 cm. long and across, acute at apex when young, becoming  $\pm$  rounded, drying pale brown, closely and deeply wrinkled; outer layer not detaching cleanly from stone, ca. 1 mm. thick, compact; stone spherical, ca. 1.5 cm. long and across, rounded at apex, the walls ca. 0.7 mm. thick, smooth, not marked; spongy layer initially thick.

TYPE: Annam [Vietnam], Nhatrang, presqu'île de Nui Hon Heo, 100 m., 3 May 1925, *Poilane 6172* (holotype, B; isotypes, A, K).

DISTRIBUTION. Vietnam (MAP 33).

ADDITIONAL SPECIMENS SEEN. **Vietnam:** Nhatrang, presqu'île de Nui Hon Heo, *Poilane 6207* (P), *Poilane 6234* (B, BM, K); Nhatrang and vicinity, *C. B. Robinson 1478* (K, NY, P); Phanrang, Cana, 200 m., *Poilane 9612* (K, P), 400 m., *Poilane 12512* (B, K, P).

ECOLOGY. Tree sometimes of rather poor form, stony ground, 100–400 m.

alt. Flowering April, May, and October (flower scented); submature fruit in October.

*Calophyllum ceriferum* can be recognized by its short, plump terminal bud; its small, more or less obovate leaf blades with subdistant, steeply ascending venation; and its more or less obvious grayish, waxy covering on the vegetative parts of the plant. The pedicels are markedly incrassate in fruit, the flowers have eight tepals, and the submature fruit has a compact outer layer about 1 mm. thick and stone walls about 0.7 mm. thick. The epithet *ceriferum* ("wax bearing") refers to the waxy covering of the plant.

*Calophyllum ceriferum* is perhaps close to the variable *C. pentapetalum*, from the Philippine Islands, but can be distinguished from that species by the characters given in the diagnosis.

The specimens of *Calophyllum ceriferum* from Phanrang, as well as *Robinson 1478*, from Nhatrang, have small leaves with rather dense venation; the leaves are frequently, but not always, separated by internodes of equal length, and the bud has subadpressed, grayish indumentum. The other specimens have larger leaves with more distant venation, the terminal internode of an innovation is often markedly shorter than the others, and the terminal bud has brown, subtomentose indumentum. However, all specimens have a short, plump, terminal bud, the hairs are similar in structure, there is no absolute difference in leaf size and venation density, the inflorescences and flowers are similar, and the pedicels are long, becoming markedly incrassate in fruit. The grayish (waxy) covering of the leaf alluded to by Gagnepain (*loc. cit.*) is not always obvious, but is best developed on *Robinson 1478*.

Formal description of *Calophyllum ceriferum* is necessary since Gagnepain's description is invalid, being in French.

#### 98. *Calophyllum* sp.

*C. brachyphyllum* auct., non Merr.; Meijer, Symp. Ecol. Res. Humid Trop. 347. 1965.

Tree 7.5–20 meters tall, d.b.h. to 20 cm.; trunk with rounded buttresses (*SAN 51735*); outer bark pale yellow to red-brown, thin, shallowly fissured, smooth, or scaly-flaky in oblong scales.

Twigs slightly flattened, 1–1.7 mm. across,  $\pm$  strongly 4-angled, drying blackish brown, at least sometimes puberulent when young; axillary innovations lacking basal scars; internodes 0.5–4 cm. long; uppermost pair of axillary buds rounded, ca. 0.3 mm. long, erect; terminal bud narrowly conical, 1–2 mm. long, with adpressed, brown indumentum (hairs, *FIGURE 31, g*), underdeveloped internode absent. Petiole 1.5–5 mm. long, deeply concave above, convex below, glabrescent; lamina suborbicular to elliptic or obovate, 1.1–4.2 by 0.9–2.5 cm., slightly retuse to bluntly pointed at apex, cuneate to shallowly cordate at base, slightly undulate and not recurved at margin, coriaceous, drying umber to fuscous above and bay to umber below, glabrous when mature, the midrib above abruptly narrowed at base, flat to slightly raised, 0.15–0.25 mm. wide at midpoint, below raised, striate, not very conspicuous,

the venation obscure to apparent above and  $\pm$  apparent below, raised, 7 to 9 veins/5 mm., angle of divergence 40–60°. Inflorescences terminal and/or from adjacent foliate axils, with 5 to 11 flowers, unbranched, the axis 2–3.5 cm. long, sparsely brown-tomentose, especially near base, lowest internode 0.5–1.3 cm. long; bracts foliaceous (?or not), to 7 mm. long, deciduous; pedicels 4–8 mm. long, glabrous. Flower known only in bud, (?)hermaphroditic; tepals 8 (rarely 9), the outer pair suborbicular, ca. 4.5 by 4 mm.; stamens 75 to 105, the anthers oblong, ca. 1.5 mm. long, truncate to retuse at apex; ovary ca. 1 mm. long, style ca. 1.5 mm. long, stigma ca. 0.5 mm. across. Immature fruit  $\pm$  ellipsoid, ca. 8 by 5 mm.; outer layer probably ca. 0.3 mm. thick; stone walls probably very thin; spongy layer unknown.

DISTRIBUTION. Northeastern Borneo (MAP 35).

SPECIMENS SEEN. **Borneo.** SABAH. Ranau: Bukit Ampuon, 1280 m., *SAN 21074* (A, CANB, K, KEP, L, LAE, SAN, SAR). Kinabatangan: Mt. Tavai, Karamuak, 610 m., *SAN 51735* (A, SAN). Lahad Datu: NW. ridge of Mt. Silam, 19 km. WSW. of Lahad Datu, 762 m., *SAN 15045* (A, BO, BRI, KEP, L, SING), 853 m., *SAN 75168* (SAN).

ECOLOGY. Hillsides and ridges, in soil derived from ultramafic rock; 610–1280 m. alt. Flowering March and July.

*Calophyllum* sp. 98 is very similar to small-leaved specimens of *C. pentapetalum* var. *buxifolium*, differing mainly in its more narrowly conical terminal buds and in the characteristically dark-drying (umber to fuscous) upper lamina surface. The lowest internode of the axillary innovation is often notably longer than the others. All specimens were collected at moderate elevations in areas of ultramafic rock, and this may in part be responsible for their rather distinctive facies. However, it is best to segregate them as a distinct, but unnamed, taxon close to *C. pentapetalum*, at least until fruits are known.

*Calophyllum* sp. 98 can be readily distinguished from *C. brachyphyllum* by its less coriaceous leaves with less dense venation, and by its larger, often terminal inflorescences. The two taxa are not immediately related.

Although *Calophyllum* sp. 98 shows considerable variation in lamina shape, the extremes (suborbicular blade subcordate at the base vs. obovate blade cuneate at the base) are connected by intermediates.

99. *Calophyllum clemensorum* P. F. Stevens, sp. nov. FIGURE 32, c, d.

*C. rotundifolium* auct., non Ridley; Meijer, Symp. Ecol. Res. Humid Trop. 347. 1965.

A speciebus aliis Calophylli in lamina basi cordata, venulis lateralibus manifestis, inflorescentia terminali, floribus saepe cum 12 tepalis, et fructu parvo circa 1.1 cm. longo strato exteriori compacto circa 0.2–0.3 mm. crasso e putamine munde secedens, differt.

Shrub to tree 3.9–15 meters tall, d.b.h. to 30 cm.; bark not known.

Twigs flattened, 2–2.5 mm. across, usually strongly 4-angled, drying dark brown, sparsely and transiently puberulent; axillary innovations usually with basal scars; internodes 1.5–3 cm. long; the upper pair of axillary buds rounded, to 0.7 mm. long,  $\pm$  spreading; terminal bud conical, 2–2.5 mm. long, with grayish indumentum (hairs, FIGURE 31, a), underdeveloped internode to 1 mm. long. Petiole 1–3 mm. long, narrowly concave above and convex below, glabrescent; lamina orbicular to lingulate, (1.7–)2.7–7.3 by (1.5–)2.4–6.3 cm., obtuse to retuse at apex, cordate at base, slightly undulate and somewhat recurved at margin, coriaceous, drying umber to sepia on both surfaces, glabrous at maturity, the midrib above  $\pm$  quickly narrowed near base, flat to slightly raised, 0.15–0.3 mm. wide at midpoint, below raised, slightly striate, the venation  $\pm$  apparent on both surfaces, raised, 7 to 12 veins/5 mm., angle of divergence 65–75°. Inflorescences terminal (also from adjacent foliate axils), with 9 to 25 flowers (flabellate and/or with branches to 3.5 cm. long and with 7 flowers), the axis 3–4.5 cm. long, glabrous or sparsely puberulent toward base, lowest internode 0.6–1.2(–2) cm. long; bracts oblong to ovate, 2.5–4 mm. long, or foliaceous, to 1.5 cm. long, subpersistent; pedicels 0.5–1.5 cm. long, sometimes sparsely puberulent when young. Flower (?) hermaphroditic; tepals (11 or) 12 (or 13) [8 or 9 in *SAN 17252*], the outer pair broadly ovate, 4–6 by 3.7–5 mm., the inner ones obovate to elliptic, 6.5–12.5 by 2.5–6 mm., sometimes glabrous; stamens 110 to 195, the filaments to 4.5 mm. long, the anthers oblong, (0.9–)1.3–1.8 mm. long, retuse at apex; ovary 1.2–1.7 mm. long, the style ca. 3 mm. long, the stigma subpeltate, ca. 0.7 mm. across. Submature fruit ellipsoid, ca. 1.1 by 1 cm., rounded at apex, drying vinaceous-brown, sharply wrinkled; outer layer detaching cleanly from stone, 0.2–0.4 mm. thick, compact; stone ellipsoid, ca. 10 by 8 mm., rounded at apex, the walls ca. 0.2 mm. thick, smooth, unmarked; spongy layer (?) thin.

TYPE: North Borneo [Sabah], Penibukan, 5000 feet [1524 m.], 11 Nov. 1933, *J. & M. S. Clemens 50316* (holotype, A; isotypes, G, K, MICH, NY, UC).

DISTRIBUTION. Northeastern Borneo (MAP 33).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SABAH. Ranau: Mt. Kinabalu, Penibukan, head of Dahobong R., 1524 m., *Clemens 40705* (A, G, K, NY, UC), 1524 m., *Clemens 30984* (BO), 1219–1524 m., *Clemens 31428* (BO); W. Marai Parai, 1219 m., *Clemens 35038* (BO, NY); Pentaturan Basin, 2134 m., *Clemens s.n.*, 27 July 1933 (BO). Kinabatangan: G. Tonsuon, 975 m., *SAN 17252* (?) (A, BO, KEP).

ECOLOGY. Lower montane rain forest, 975–2135 m. alt.; near Mt. Kinabalu on sometimes dry ridges. Flowering February, May, July, and October; submature fruit in April.

In *Clemens 35038* the stem is much swollen in places, apparently being galled, and is up to 1 cm. across. This swelling may also occur on the midrib of the lamina, which then becomes woody.

*Calophyllum clemensorum* can readily be distinguished from the other Malesian species of *Calophyllum* with a cordate-based lamina by its strongly

four-angled twigs, distinct venation, terminal inflorescence, flowers usually with more than eight tepals, and ellipsoid fruits with a thin, compact outer layer that detaches easily from the thin-walled stone. This species is named after the collectors and missionaries J. and M. S. Clemens (for an excellent photograph of the couple, see Fl. Males. 1(1): 109. 1950).

Although the leaves of *Calophyllum clemensorum* are superficially like those of *C. rotundifolium* (see Meijer, *loc. cit.*; E. D. Merrill also identified Clemens's specimens as *C. rotundifolium*), that species has more profusely branched, only slightly angled twigs, leaves with the midrib below more or less depressed and not very distinct, and a terminal inflorescence consisting of only one or two flowers. The flowers of *C. rotundifolium* are larger than those of *C. clemensorum* and have very thick outer tepals.

*Calophyllum clemensorum* is superficially similar to *C. vergens* (*C. thwaitesii* Planchon & Triana 'β'), from the mountains of Sri Lanka. However, the latter species has axillary inflorescences, flowers with only eight tepals, a somewhat longer terminal bud, and much larger fruits with a thicker outer layer.

SAN 17252 is the only specimen of *Calophyllum clemensorum* that has eight (or nine) tepals, and it also has a thicker lamina than the others. It is a poor specimen, however, and further collections from Gunong Tonsuon may show that it belongs to the variable *C. teysmannii* complex.

The above description of the fruit is based on detached fruits on the sheets of Clemens 35038.

100. *Calophyllum tetrapterum* Miq. Pl. Jungh. 291. 1854. TYPE: Sumatra, Angkola superior, 1000-3000 pedes [310-925 m.], *Junghuhn s.n.* (holotype, U; isotypes, BO, I).

Shrub 1.5 meters tall or tree 3-20 meters tall, d.b.h. to 40 cm.; trunk lacking buttresses but occasionally with stilt roots; outer bark whitish to yellowish or brown, shallowly fissured or smooth (rarely brown, deeply fissured), usually hoop marked, the inner surface orange(-red) to blackish; under bark reddish or reddish and yellow mottled; inner bark reddish; latex usually clear to opaque yellow, sticky (rarely white to whitish or yellow, fluid, not sticky).

Twigs slightly flattened, 1.3-2.8(-3.5) mm. across, strongly 4-angled (to ± rounded), drying brown to blackish or yellowish, glabrous or ± sparsely and transiently brown-pubescent; axillary innovations usually lacking basal scars; internodes 0.5-5 cm. long; uppermost pair of axillary buds rounded, 0.5-1.5 mm. long, spreading; terminal bud plump, 1.5-4 mm. long, with short, adpressed, grayish, to short-tomentose, brown indumentum (hairs, FIGURE 31, m, n, q; cf. 20, i-l, and 22, k, l), underdeveloped internode 0.5-2(-3) mm. long. Petiole 0.4-1.4(-2) cm. long, ± deeply concave above, convex below, at most transiently puberulent below; lamina elliptic to obovate (oblong), (2.2-)3.5-14 by (1-)1.6-6.5 cm., acuminate or acute to rounded at apex, cuneate to acute at base, at margin sometimes with band of thickening to 1 mm. wide, or clear submarginal vein, undulate but not recurved or only slightly

so,  $\pm$  coriaceous, drying umber to gray-olivaceous above, margin often paler, or color obscured by pruinose covering, and cinnamon to olivaceous below, glabrous or sparsely puberulent to subtomentose on midrib below, the midrib above gradually narrowed from base, usually sharply raised (almost level), 0.15–0.45 mm. wide at midpoint, below raised or slightly raised, somewhat striate, the venation on both surfaces usually apparent, raised, (4 or) 5 to 14 (to 17) veins/5 mm., angle of divergence (50–)65–75°. Inflorescences usually axillary (terminal), with 3 to 11 flowers, unbranched, the axis (0.3–)1–4 (–7.5) cm. long, glabrous or short-puberulent to subtomentose toward base, lowest internode 0.4–3.5 cm. long; bracts usually small and fugaceous (foliaceous, to 2 cm. long, subsistent); pedicels (0.2–)0.5–2(–3) cm. long, glabrous, usually very slender, frequently incrassate and to 2.5 mm. thick in fruit. Flower (?) hermaphroditic; tepals 4 or 8 (rarely 5 to 7, or 10), the outer pair ovate to broadly elliptic, 2.2–5 by 2–4 mm., sometimes papillate or puberulent on back near apex, the inner ones elliptic to lingulate, 3.5–8.5 by 1.5–3.5 mm.; stamens 25 to 105 (to 135), the filaments to 4.5 mm. long, the anthers suboblong, (0.4–)0.7–1.2 mm. long, shallowly retuse at apex; ovary 0.8–1.3 mm. long, the style to 3.5 mm. long, the stigma peltate, ca. 0.4 mm. across, slightly lobed. Fruit ellipsoid to spherical, 6.5–16 by 5–12 mm., apiculate or rounded at apex, drying grayish to pale brown, sharply wrinkled when young, at least sometimes smooth when mature; outer layer usually not detaching cleanly from stone, 0.25–0.5(–1.3) mm. thick, with large air spaces developing; stone spherical to ellipsoid, 5.5–11 by 5–10 mm., rounded at apex, the walls 0.1–0.2(–0.35) mm. thick, smooth, unmarked; spongy layer thin.

#### Key to the Varieties of *Calophyllum tetrapterum*

1. Lamina with clear submarginal vein, or submarginal band of thickening (0.2–)0.4–1 mm. wide, (4 or) 5 to 7 (to 10) veins/5 mm.; floral bracts sometimes subsistent. . . . . 100b. var. *obovale*.
1. Lamina lacking distinct submarginal vein, marginal band of thickening less than 0.4 mm. wide, usually more than 7 veins/5 mm.; floral bracts soon deciduous.
  2. Lamina with obscure venation on lower surface, 5 to 7 veins/5 mm. . . . . 100c. var. *blumutense*.
  2. Lamina with  $\pm$  clear venation on lower surface, (5 to) 8 or more veins/5 mm. . . . . 100a. var. *tetrapterum*.

#### 100a. *Calophyllum tetrapterum* Miq. var. *tetrapterum*

- C. tetrapterum* Miq.; Walp. Ann. Syst. Bot. 4: 367. 1857; Miq. Fl. Indiae Batavae 1(2): 510. 1857, *ibid.* Suppl. 3(2): 1861; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 293. 1862; Vesque in C. DC. Monogr. Phanerog. 8: 610. 1893; H. Keng, Gard. Bull. Singapore 28: 245. 1976.
- C. bancanum* Miq. Fl. Indiae Batavae, Suppl. 1(3): 499. 1861; Kurz, Nat. Tijdschr. Nederl.-Indië 27: 192. 1864; F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868; Scheffer, Nat. Tijdschr. Nederl.-Indië 31: 354. 1870, *ibid.* 32: 405. 1873. TYPE: Bangka, Djebus, *Teysmann, HB 3214* (holotype, U; isotypes, BO, K, L).



- C. gracile* Miq. Fl. Indiae Batavae, Suppl. 1(3): 498. 1861; F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868; *C. pulcherrimum* Wall. ex Choisy var. *gracile* (Miq.) Boerl. Catal. Horto. Bogor. 2: 82. 1901, *excl. spec. cit.* TYPE: Sumatra, prope Paja-Kombo, *Teysmann, HB 649* (holotype, u; isotypes, BO, K (s.n.), L, MEL (s.n.)).
- C. floribundum* Hooker f. Fl. Brit. India 1: 272. 1874, *pro parte*; King, Jour. Asiatic Soc. Bengal, II. 59: 175. 1890; Ridley, Fl. Malay Penin. 1: 184. 1922; M. R. Henderson, Gard. Bull. Straits Settl. 4: 224. 1928; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 332. *pl.* 16. 1956; Smythies, Common Sarawak Trees, 61. 1965; Kochummen, Malayan Forest Rec. ed. 2. 17: 215. 1965; I. H. Burkill, Dict. Econ. Prod. Malay Penin. ed. 2. 1: 412. 1966; T. C. Whitmore, Tree Fl. Malaya 2: 180. 1973; Corner, Gard. Bull. Singapore, Suppl. 1: 104. 1878. TYPE: Malaya, Malacca, 1 Jan. 1867, *Maingay 1660* (*Kew dist.* 170) (lectotype, K).
- C. praeineanum* King, Jour. Asiatic Soc. Bengal, II. 59: 175. 1890; Vesque in C. DC. Monogr. Phanerog. 8: 550. 1893; Ridley, Fl. Malay Penin. 1: 183. 1922. SYNTYPES: Malaya, Perak, Larut, less than 100 feet [30 m.], Dec. 1883, *King's collector* [*Kunstler*] 5366 (BM, FI, G, K, P, UC), 800–1000 feet [240–305 m.], Feb. 1885, *King's collector* [*Kunstler*] 7243 (BM, FI, K, P).
- C. venustum* King, Jour. Asiatic Soc. Bengal, II. 59: 180. 1890; Vesque in C. DC. Monogr. Phanerog. 8: 549. 1893; Ridley, Fl. Malay Penin. 1: 186. 1922. TYPE: Malaya, Perak, Larut, 300–350 feet [90–105 m.], July 1885, *King's collector* [*Kunstler*] 7763 (isotypes, FI, G, K).
- C. foetidum* Ridley, Jour. Straits Branch Roy. Asiatic Soc. 54: 18. 1910, *pro maxime parte*, Fl. Malay Penin. 1: 186. 1922, *pro parte*. TYPE: Singapore, Gardens Jungle, anno 1904, *Ridley 11958* (lectotype, SING; isolectotypes, BM, K).
- C. lanceola* Ridley, Jour. Straits Branch Roy. Asiatic Soc. 82: 170. 1920, Fl. Malay Penin. 1: 182. 1922. TYPE: Malaya, Kedah, Kedah Peak, 4000 feet [1219 m.], *Ridley 5751* (holotype, SING).
- C. rupicola* Ridley var. *elatum* T. C. Whitmore, Gard. Bull. Singapore 26: 270. 1970, *pro minore parte*, Tree Fl. Malaya 2: 169. 1973, *pro minore parte*. TYPE: Malaya, Kelantan, Ulu Sat F.R., 180 m., 2 Feb. 1970, *FRI 2538* coll. *Kochummen* (holotype, KEP; isotypes, K, L, SING).
- C. pulcherrimum* auct., non Wall. ex Choisy; T. Anderson in Hooker f. Fl. Brit. India 1: 271. 1874, *pro parte*; Pierre, Fl. Forest. Cochinch. 1: *pl.* 104A. 1885, *pro parte*; Vesque, Epharmosis 2: *t.* 21. 1889, in C. DC. Monogr. Phanerog. 8: 570. 1893, *pro parte*; Curtis, Jour. Straits Branch Roy. Asiatic Soc. 25: 78. 1894; Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 321. 1910; Ridley, Fl. Malay Penin. 1: 182. 1922, *pro parte*; I. H. Burkill & M. R. Henderson, Gard. Bull. Straits Settl. 3: 347. 1925; Craib, Fl. Siam. Enum. 1: 121. 1931; Gagnep. in Humbert, Fl. Gén. Indo-Chine, Suppl. 1: 274. 1943; Pham & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. 1960; Pham, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. 2: 301. *fig.* 1970, *pro parte*.
- C. amoenum* auct., non Wall. ex Choisy; Vesque in C. DC. Monogr. Phanerog. 8: 576. 1893, *quoad King 548*.
- C. griffithii* auct., non T. Anderson; Baker f. Jour. Bot. London 62(Suppl.): 8. 1924.
- C. dryobalanoides* auct., non Pierre; Craib, Fl. Siam. Enum. 1: 120. 1931;

Gagnep. in Humbert, Fl. Gén. Indo-Chine, Suppl. 1: 274. 1943, *pro parte*.  
*C. globuliferum* Ridley, Kew Bull. 1938: 121. 1938, *typo excluso*.  
*Calophyllum* sp. Craib in Schmidt, Bot. Tidsskr. 32: 328. 1915.

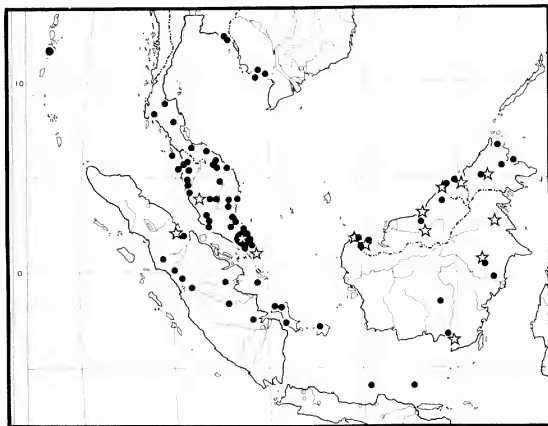
Tree 6–30 meters tall, d.b.h. to 38 cm.; outer bark closely fissured; latex clear to opaque yellow (rarely white to whitish (*SAN* 22940, 71512)), sticky.

Twigs slightly flattened, usually strongly 4-angled; axillary innovations nearly always lacking basal scars. Lamina elliptic to obovate (rarely suboblong), 3.7–13.5 by 1.6–5.2 cm., usually acuminate (acute) at apex, usually notably pale at margin, marginal thickening less than 0.4 mm. wide, thinly coriaceous, the venation  $\pm$  clear above and below, (5 to) 8 to 14 (to 17) veins/5 mm. Inflorescences axillary; bracts very fugaceous, usually lost even in very young inflorescences.

DISTRIBUTION. Cambodia to Borneo, excluding mainland Java (MAP 34).

SELECTED SPECIMENS SEEN ("e" denotes atypical specimens—see notes at end).

**Vietnam:** Phu Quoc, *Pierre* 3645 (p), near Hatien, *Poilane* 876 (κ, p). **Cambodia:** Kampot, Mt. Bokor, 1000 m., *Smitinand & Abbe* 6511 (κ). **Thailand:** Krat, Kookrap, 700 m., *Kerr* 17772 (BM, κ), Kao Saming, *Put* 567 (κ); Kaw Koh Chang, Klong Munse, *Schmidt* 528 (c, κ); Klong Majum, *Schmidt* 603A (c, κ), Klawng Non Si, 50 m., *Kerr* 9175 (A, C, E, K, L, p); Krabi, Ao Luk, 50



MAP 34. Distribution of *Calophyllum tetrapterum* var. *tetrapterum* (circles), *C. tetrapterum* var. *blumutense* (star in solid circle), and *C. tetrapterum* var. *obovale* (stars) in Southeast Asia-Malesia.

m., *Kerr* 18567 (A, BM, C, K, P); Terutas, Satul, 5 m., *Kerr* 14213 (BM, C, K, L, P); Huey Tonpong, Bandom, *FDS* 874 (BKF, K); Songkla, Sadao, Khao Le, *Premrasmi* 183 (KEP); Tanto, *Nim* 41 (BKF); Pen[insula], Narathiwat, Waeng, *Nitrasirirak* 206 (?) (BKF). **Andaman and Nicobar Islands.** S. ANDAMAN: Tusonobad, *King's collectors s.n.*, 23 Jan. 1893 (BO, K, P, U). **Malaya.** KEDAH: Kedah peak, 792 m., *KEP* 94422 (A, BO, K, KEP, NY, SING); Bukit Enggang F.R., 427 m., *FRI* 13730 (e) (A, K, SAN, SING); Sik catchment area, *FRI* 16289 (e) (A, KEP, SAR); Langkawi, G. Raya, *Corner s.n.*, 15 Nov. 1941 (SING), Bukit Sawak F.R., *KEP* 66442 (KEP), Sungei Batu Asap, 150 m., *Ridley* 15540 (BM, K, SING); Perangin F.R., *KEP* 79283 (SING); Kuala Muda, Gurun, Jerai F.R., *KEP* 17925 (SING); Bukit Malut, *KEP* 7683 (SING). PINANG: Muku head, 150–240 m., *Curtis* 418 (?) (e) (K, SING); Pulau Penang, above waterfall garden, *SFN* 3368 (BO, SING), Penang Hill, 762 m., *FRI* 20525 (KEP), Pantai Acheh F.R., *KEP* 72565 (KEP). PERAK: Larut, 150–240 m., *King's collector* 3378 (K, P); Lumut F.R., 120 m., *FRI* 977 (?) (e) (A, K, KEP, SAN, SING); Taiping Hill, *J. W. Anderson* 114 (SING); Batu Undan F.R., 305 m., *KEP* 54223 (KEP). SELANGOR: Ulu Gombak F.R., *FRI* 2213 (A, K, SAN, SING); 22 mile Ginting Simpah, *KEP* 12854 (SING); Bukit Lagong F.R., *KEP* 80646 (KEP). NEGRI SEMBILAN: Kuala Pilah, Serting F.R., *KEP* 62955 (A, K, KEP, SING); Senaling Inas F.R., *KEP* 62882 (KEP); Pedas, G. Angsi F.R., 457 m., *FRI* 14620 (KEP, SAR, SING). MALACCA: Pulau Besar, *Stone* 9034 (BISH, G, KLU, MO); Pulo Pesar, *Griffith*, *Kew* dist. 877 (BO, E, G, K, P); Bukit Bruang, 0 m., *Derry* 393 (BM, K, SING); Bukit Sandanan, 0 m., *Derry* 514 (K, SING). KELANTAN: Sungei Anak Ketil, S. of G. Rabong, 305 m., *FRI* 20705 (KEP, SAN); Kemansul F.R., *KEP* 99583 (e) (KEP); Ulu Sat F.R., Machang, *KEP* 100143 (A, K, KEP, SING); Pasir Mas, Gual Periok, *KEP* 66804 (KEP); Ulu Temiang F.R., Gua Musang, *KEP* 104284 (A, K, KEP, SAN, SING); G. Rabong, 610 m., *FRI* 20617 (KEP); Kuala Krai, Sungei Durian F.R., *KEP* 104728 (K, KEP, SING); Kemahang F.R., 18 m., *KEP* 93588 (KEP). TRENGGANU: along Sungei Pelong, *FRI* 14841 (K, KEP, SAR, SING); Jerangau F.R., 180 m., *KEP* 78562 (KEP); Dungun, Ulu Chukai F.R., *KEP* 100059 (KEP); 40th mile Jerteh Road, Sungei Tong, *FRI* 2521 (K, KEP, SAR, SING); path to G. Tebu, Jabi, 610 m., *Shah et al.* 3306 (SING). PAHANG: Menchali F.R., *KEP* 94898 (A, KEP, SAN, SAR, SING); Aur F.R., *FRI* 3646 (A, KEP, SING); Ulu Sungei Kelui, 610 m., *FRI* 10956 (e) (A, K, KEP, SING); Ulu Sungei Anak Endau, 396 m., *FRI* 8174 (A, K, KEP, SAR, SING); Kerdau, *KEP* 29997 (KEP); Rotan Tunggul F.R., *KEP* 23389 (K, KEP, SING); Lepar Hill F.R., 150 m., *FRI* 9186 (e) (KEP); Baloh F.R., *KEP* 66646 (KEP); Ulu Perah, *KEP* 11212 (KEP); Kuantan, Sungei Sawah Chini, *KEP* 2712 (?) (K, KEP, SING); Ginting Highlands, 915 m., *Stone* 7443 (BISH, KLU); Bukit Simpul, *KEP* 15638 (SING); Kemasul F.R., 45 m., *KEP* 87741 (KEP). JOHORE: Mawai, *SFN* 34748 (A, BO, K, KEP, SING); Labis F.R., G. Besar Massif, *FRI* 14014 (?) (e) (A, K, KEP, SAN, SING); G. Panti Timor, 478 m., *FRI* 7770 (KEP, SING); Johore Coast, Tg. Penawar, 15 m., *FRI* 7629 (A, K, KEP, SING); Kangka Sedili Kechil, *SFN* 28599 (K, KEP, SING); Jemaluang F.R., *KEP* 73463 (KEP); Lenggor F.R., *KEP* 72652 (KEP); G. Arong F.R., 30 m., *KEP* 71312 (KEP). **Singapore:** Bukit Timah F.R., *SFN* 38848 (A, BO, LAE, SING); Botanic Gardens jungle, *SFN* 36255 (A, BO, K, KEP, LAE, P, SING); Changi, *Goodenough* 1958 (SING); Jurong, *Corner s.n.*, 14 Jan. 1932 (SING); SW. side of Seletar Reservoir, upper Mandai, *SFN* 40014 (SING); N. side of MacRitchie Reservoir, *Sinclair* 5372 (SING). **Sumatra and adjacent islands.** RIAU: Lingga Arch., Pulau Singkep, *bb* 2714 (BO); Kocantan, Tjerenti, 50 m., *bb* 25239 (?) (BO, L). DJAMBI: Moera Tembesie, Soengei Roean, 15 m., *bb* 9250 (e)

(BO). SELATAN: Koeboestreken, 10–20 m., *Endert 256* (BO, L). BARAT: Loeobek Sikaping, Tandjong Boengo, 370 m., *bb 6512* (e) (BO); Sidjoengdjoeng, Moeara, 596 m., *bb 6057* (BO). UTARA: Laboehan Batoe, Kota Pinang, Langga Pajoeng, *si Toroes 3354* (A, NY, US). BANGKA: G. Permisian, Soengei Selan, 450 m., *Bünnemeyer 2046* (BO, L); G. Maras, Soengei Liat, 500 m., *bb 1954* (BO, L); Gadoeng, 20 m., *bb 10579* (?) (BO). BELITUNG: Tandjong Pandan, Bantan, 20 m., *bb 7376* (BO). BORNEO. SARAWAK. 1st Division: Semengoh Arboretum, 15 m., *S 5361* (BO, K, KEP, L, P, SAN, SAR, SING); Lundu, G. Pueh, 160 m., *S 13724* (A, BO, K, L, SAN, SAR, SING); G. Gading, 760 m., *S 13325* (?) (A, BO, SAN, SAR, SING); G. Santubong E., 762 m., *S 13695* (K, L, SAN, SAR, SING). 4th Division: Bukit Mentagei, Bok-Tisam Marudi, 610 m., *S 23286* (A, K, KEP, SAN, SAR, SING); Bukit Mersing, Anap, 400 m., *S 21926* (A, BO, K, SAN, SAR, SING). BRUNEI: Berakas F.R., 60 m., *S 7820* (A, BO, K, KEP, NY, SAR, SING); Andalau F.R., 15 m., *SAN 17529* (A, BO, K, KEP, SING); Kuala Belait, *S 1945* (SAR). SABAH. Kudat: Lokapas, Bengkoka, 72 m., *SAN 1827* (A, BO, K, US). Keningau: Sook plain, mile 1½ Tulid road, *SAN 55615* (SAN). Labuk & Sugut: base of Bukit Mesasau, 180 m., *SAN 25429* (BO, K, KEP, L, SAN, SAR); Telupid, mile 87, 120 m., *SAN 71474* (SAN). Sandakan: Leila F.R., *A 2712* (A, K, KEP, KLU, SING, US); Sepilok F.R., 120 m., *A 3880* (A, K, KEP, SAN, SING); Sungei Kapur, *SAN 22940* (SAN, SAR); Batu Sapi, Mt. Walker, *SAN 61592* (SAN). KALIMANTAN. Timur: Central Kutei, Belajan R., *Kostermans 10254* (A, BO, K, LAE, P, SING); E. Kutei, *Kostermans 7248* (A, B, BO, CANB, G, K, LAE, P, SING). Selatan: Bukit Besae, 305 m., *Motley 304* (K). Tengah: Beneden Dajak, 40 m., *bb 8159* (BO). Java and adjacent islands. BAWEAN Is.: Mt. Besar, 400 m., *Buwalda 3224* (BO, L). KARIMOENDJAWA: Japara, 150 m., *Ja 1705* (BO).

ECOLOGY. Usually in well-drained mixed dipterocarp forest; often common on sandy, acid soil (eastern Sabah); sometimes on highly leached, giant podzols (elsewhere in Borneo); in swamp forest (Malaya) (Corner, *loc. cit.*, as *C. floribundum*; *FRI 2521*, *Sinclair 7763*); on ultramafic rock (Borneo); in evergreen forests (Thailand); to 975 m. alt. On mainland SE. Asia flowering mostly December to February, rarely in March, April, July, August, and November; data from the rest of Malesia scanty, but flowering perhaps more scattered. Flower scented, sometimes fetid ("very foetid, [smelling] of garlic when decaying"—*SFN 33143*). Fruiting February to May, rarely at other times; fruit yellowish or bluish green, eaten by iban patong (*SFN 28599*, Johore).

One atypical specimen has bilabiate galls (*FRI 14014*, Johore).

GERMINATION AND YOUNG PLANT. The radicle breaks through the stone to one side of the base. The seedling has two pairs of leaves separated by well-developed internodes over 1 cm. long. Subsequently produced internodes are longer, the terminal bud is functional, and growth is erect. (*Stevens et al. 121*; *Stone 9034*.)

100b. *Calophyllum tetrapterum* Miq. var. *obovale* (Miq.) P. F. Stevens, comb. et stat. nov.

*C. obovale* Miq. Fl. Indiae Batavae, Suppl. 1(3): 498. 1861; F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868; Vesque in C. DC. Monogr. Phanerog.

**8:** 606. 1893. TYPE: Sumatra, ad littoram Siboga, *Teysmann*, HB 644 (holotype, U; isotypes, BO, K, L, MEL, P).

*C. griffithii* T. Anderson in Hooker f. Fl. Brit. India **1:** 273. 1874; King, Jour. Asiatic Soc. Bengal, II. **59:** 179. 1890; Vesque in C. DC. Monogr. Phanerog. **8:** 602. 1893; Ridley, Fl. Malay Penin. **1:** 187. 1922, *pro parte*; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15:** 312. 1956; T. C. Whitmore, Tree Fl. Malaya **2:** 168. 1973. TYPE: Malaya, Malacca, *Griffith*, *Kew dist.* 882 (holotype, K; isotypes (sometimes *s.n.*), BO, E, GH, L, M, P).

*C. globuliferum* Ridley, Kew Bull. **1938:** 121. 1938, *paratype excepto*; Masamune, Enum. Phanerog. Born. 475. 1942. TYPE: Dutch SE. Borneo [Kalimantan], Bangarassing, *Motley* 618 (holotype, K).

*C. elegans* auct., non Ridley; Keith, N. Borneo Forest Rec. ed. 2. **2:** 313. 1952.

Tree 3–20(–27) meters tall, d.b.h. to 20 cm.; outer bark smooth or rather distantly fissured; latex clear yellow, fluid, becoming opaque when rubbed.

Twigs flattened, usually not strongly angled; axillary innovations sometimes with basal scars. Lamina obovate (rarely elliptic to oblong), (2.2–)3.7–9.5(–14) by (1–)2–5(–6.5) cm., rounded to shortly and bluntly acuminate at apex, usually notably pale at margin, marginal thickening (0.2–)0.4–1 mm. wide, rarely with clear submarginal vein ca. 0.7 mm. from margin, thinly coriaceous to coriaceous, the venation  $\pm$  clear on both surfaces, (4 or) 5 to 8 (to 10) veins/5 mm. Inflorescences sometimes terminal; bracts sometimes foliaceous, up to 2 cm. long, subsistent.

DISTRIBUTION. The Malay Peninsula, Sumatra, and Borneo; scattered (MAP 34).

SELECTED SPECIMENS SEEN. **Malaya.** PERAK: G. Besut, *Soepadmo s.n.*, 28 Nov. 1973 (BISH, KLU). **Sumatra and adjacent islands.** RIAU: Riouw Arch., P. Bintan, S. Poelei, 30 m., *Bünnemeyer* 6335 (BO, L). UTARA: Laboehan Batoe, Kota Pinang, Kaloebi, Goenoeng Si Papan, *si Toroos* 3471 (A, US), Langga Pajoeng, *si Toroos* 3409 (intermediate) (A, K, L, NY, US), *si Mandi Angin*, *si Toroos* 3983 (intermediate) (A, US). **Borneo.** SARAWAK. 1st Division: Bukit Jebong, Bau, *S* 25605 (A, K, KEP, L, SAN, SAR, SING); G. Pueh, Sematan, 628 m., *S* 34475 (A, SAN, SAR). BRUNEI: Anduki F.R., *KEP* 37144 (K, KEP); Bukit Puau, 12 m., *Ashton s.n.*, July 1959 (SAR); Temburong, Bukit Patoi, 281 m., *SAN* 17132 (A, BO, K, KEP, L, SAN, SING); Berakas F.R., 30 m., *S* 4926 (intermediate) (SAR). SABAH. Sipitang: Mile 5, Menggalong F.R., *SAN* 21806 (A, K, SAN). Beaufort: Weston, Siangan F.R., 69 m., *SAN* 78166 (SAN). Papar: Kimanis, 24 m., *SAN* 41411 (K, L, SAN). Keningau: Sook, mile 2½ Tulid road, 917 m., *SAN* 49521 (SAN). **KALIMANTAN.** Timur: W. Kutei, Mt. Palimasin near Tabang on Belajan R., 700 m., *Kostermans* 12899 (BO, K, L); Boelongen, Sungei Binai, *Rutten* 20 (BO, U). Selatan: G. Pamatton, *Korthals s.n.* (L). Barat: between Mt. Klam and S. Djemela, *Hallier* 2526 (A, BO, K, L, SING).

ECOLOGY. Primary or sometimes secondary mixed dipterocarp forest, in Sarawak sometimes on limestone; 12–917 m. alt. Flowering March, April, and June (flower scented); fruiting April, June, and October (fruit reddish yellow, pedicel red (*Kostermans* 12899)).

GERMINATION AND YOUNG PLANT. The seedling has two or three pairs of scale leaves and two pairs of expanded leaves, all separated by well-developed internodes. The young plant is erect, the terminal bud is functional, and the internodes are well developed. (Two plants only: *Stevens et al.* 219A.)

The epithet *obovale* refers to the leaf shape of the type specimen.

100c. *Calophyllum tetrapterum* Miq. var. *blumutense* (M. R. Henderson & Wyatt-Smith) P. F. Stevens, comb. et stat. nov.

*C. blumutense* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 343. pl. 22. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 171. 1973.

TYPE: Malaya, Johore, Gunong Blumut, 3300 feet [1006 m.], 23 March 1923, *KEP 5880* coll. *Yeob* (holotype, SING; isotypes, K, SING).

Shrub 1.5 meters to tree 12 meters tall; bark unknown.

Twigs flattened, not strongly angled; axillary innovations lacking basal scars. Lamina elliptic (rarely suboblong), 5.5–11.3 by 2–4.3 cm., acute to subacuminate at apex, pale at margin, marginal thickening 0.2–0.35 mm. wide, coriaceous, the venation clear above, obscure below, the latex canals impressed (G. Blumut), 5 to 7 veins/5 mm. Inflorescences very rarely terminal; bracts not seen, (?)small, fugaceous.

DISTRIBUTION. Malay Peninsula, Johore (MAP 34).

SELECTED SPECIMENS SEEN. **Malaya.** JOHORE: G. Blumut, 762 m., *KEP 98052* (K, KEP); G. Panti, 488 m., *SFN 18098* (BO, K, SING).

ECOLOGY. Shrub or small tree of colline or lower montane rain forest, 488–1006 m. alt. Flowering February and March; fruiting in May.

The name of the mountain on which the type specimen was collected suggested the epithet *blumutense*.

*Calophyllum tetrapterum* is usually an easily recognizable species. It is characterized by its short terminal bud, its often strongly four-angled and soon glabrescent twigs, and its rather small, more or less chartaceous lamina with clear venation, a sharply raised midrib narrowing gradually from the base, and a pale-drying margin. The base of the dried lamina is minutely truncate where it joins the deeply concave petiole. The inflorescences and pedicels are usually slender, although the latter may become thickened in fruit; the more or less spherical fruits often dry grayish or pale brownish and sharply wrinkled. The epithet *tetrapterum* ("four winged") is appropriate, since many specimens have strongly four-angled twigs.

#### Intraspecific Variation

Henderson and Wyatt-Smith adopted a wide view of this species (see *loc. cit.*, *Calophyllum floribundum*). I have taken a yet wider view but with the recognition of three varieties. However, much work must be done to sort out the variation within the species as here delimited, as well as to clarify the relationships between *C. tetrapterum*, *C. rupicola*, and *C. pisiferum*.

The type specimen of *Calophyllum tetrapterum*, *Junghuhn s.n.*, differs from many others assigned to var. *tetrapterum*. The indumentum on the inflorescence axis and tepals in particular is relatively well developed (in some other specimens the outer tepals are more or less papillate on the back); the inflorescence axis is only 3–6 mm. long; and the rather large leaves lack a pale-drying margin. In foliar characters other specimens from Sumatra (such as *Forbes 3220a*), as well as some from Malaya, agree with the type.

Although there are a few specimens intermediate between *Calophyllum tetrapterum* vars. *obovale* and *tetrapterum* (cited under the former), the two are usually readily distinguishable by the characters given in the key above. There may also be differences in the field characters, although this needs to be confirmed. A tree of *C. tetrapterum* var. *obovale* on Bukit Jebong, near Kuching, Sarawak, had fluid latex that became opaque when rubbed, and venation that was visible on the upper surface of the lamina but invisible on the lower, the reverse of the usual case. There are also possible differences in the seedlings (see above).

*S 34475* is a very robust specimen of *Calophyllum tetrapterum* var. *obovale* with twigs up to 3.5 mm. across and notably short terminal internodes. *Kostermans 12899*, from Kalimantan, is a very small-leaved specimen referred to var. *obovale* with some hesitation: it has a terminal bud 1.5–2 mm. long, coriaceous, obovate leaf blades 2.2–5.7 by 1–2.4 cm., and fruits only 7 by 6 mm. borne on red pedicels. *KEP 48612* is an unlocalized specimen probably from Malaya that may belong here; *C. tetrapterum* var. *obovale* is less distinct in Malaya than elsewhere in its range.

The taxon *Calophyllum tetrapterum* var. *blumutense* is a very local variant, and specimens from the two mountains from which it is known differ somewhat. The latex canals on the lower lamina surface of the Gunong Panti specimen are not impressed, while those of the Gunong Blumut specimens are. When Henderson and Wyatt-Smith described *C. blumutense*, they noted that it was similar to *C. floribundum* (= *C. tetrapterum* var. *tetrapterum*) but thought that it could be distinguished by the more distant venation of the lamina. However, specimens from the Malay Peninsula (e.g., *KEP 100143*, *104284*) otherwise clearly assignable to *C. tetrapterum* var. *tetrapterum* have comparably distant venation. Henderson and Wyatt-Smith also described the fruits of *C. blumutense* as smooth, while those of *C. floribundum* were described as wrinkled. However, the fruits of the former are ripe, and there is a tendency in *C. tetrapterum* for ripe fruits to be smooth, with large air spaces disorganizing the outer layer and occupying most of the space between the stone and the skin (see also under *C. foetidum*, below).

There are a number of specimens of *Calophyllum tetrapterum* var. *tetrapterum* from the Malay Peninsula and Sumatra (cited as “e” in the list above) that are somewhat different from the others. They have a shorter, more congested inflorescence usually less than 2 cm. long, and the flowers are small. The lamina often dries darker brown on the upper surface; the margin does not dry notably paler; the venation is rather dense, with (8 to) 11 to 13 (to 15) veins/5 mm.; and the midrib on the upper surface of the leaf, although narrowing gradually from the base, is relatively little raised. The

fruit is spherical and is smooth when mature; the young fruit is at least sometimes prominently apiculate. The type specimen of *C. rupicola* var. *elatum* is a specimen of this type. In some characters (leaf color, venation density, flower, and inflorescence) these atypical specimens of *C. tetrapterum* var. *tetrapterum* approach *C. calaba* var. *bracteatum*. Yet other collections, notably some from Kelantan (e.g., KEP 104284, FRI 20705), have fruits like those mentioned above. More studies are needed to clarify the significance of this variation, and it would be premature to give these specimens formal recognition.

### Synonyms and Nomenclature

As mentioned above, the type specimen of *Calophyllum tetrapterum* differs somewhat from many of the specimens assigned to var. *tetrapterum*. Miquel (1854, *loc. cit.*) described the pedicels as sometimes being four together, although they are in pairs, separated by an internode. Miquel's description may have led Planchon and Triana (*loc. cit.*) to compare *C. tetrapterum* with *C. spectabile* (= *C. soulattri*), a very different species that often has four flowers at a node.

The type specimens of most of the names reduced to synonymy under *Calophyllum tetrapterum* var. *tetrapterum* are nearly all close matches with the common form of the variety. The specimens cited under *C. floribundum* in the original description, Maingay, *Kew dist.* 170, 172, and ?171, belong to three species. Maingay, *Kew dist.* 170 agrees with the original description and has a lamina with a notably pale margin (probably the thickened margin mentioned in the description); it is a reasonable lectotype for *C. floribundum*. Maingay, *Kew dist.* 171 belongs to *C. pulcherrimum*, and *Kew dist.* 172 is a specimen of *C. dioscurii*. The adjacent number *Kew dist.* 169 is a mixture of *C. tetrapterum* and *C. pulcherrimum*. For notes on the confusion between these last two species, which are very distinct, see the discussion after *C. pulcherrimum*.

The type specimen of *Calophyllum venustum*, King's collector 7763, has the broader leaf marginal thickening that is common in *C. tetrapterum* var. *tetrapterum*, and the lamina tends to be rounded at the apex. In both of these characters, *C. venustum* tends toward *C. tetrapterum* var. *obovale*.

The sheet of Ridley 11958 at Singapore is designated the lectotype of *Calophyllum foetidum*; the field label notes that the flowers were small, one of the characters that Ridley used in distinguishing this species. However, Ridley 11958 has rather short inflorescences, although Ridley thought that *C. foetidum* could also be distinguished by its long inflorescences. Ridley cited a number of his specimens collected in Singapore, as well as unspecified collections of Derry from Bukit Bruang, Malacca, in the protologue. Derry 393 is in flower; Derry 1103 is in fruit. (Derry 514, cited by Henderson & Wyatt-Smith (*loc. cit.*) as being from Bukit Bruang, is in fact from Bukit Sandanan.) Fruiting specimens referable to *C. foetidum* have a completely smooth, brittle outer layer, but it does not seem possible to recognize a taxon based on this character (see also above under *C. tetrapterum* var. *blumutense*).



The type specimen of *Calophyllum rupicola* var. *elatum* is probably to be referred to *C. tetrapterum* var. *tetrapterum*, although it is a somewhat atypical specimen (see above).

The type specimens of *Calophyllum obovale* and *C. globuliferum* are very similar, and both also have terminal inflorescences. However, *C. griffithii* is reduced to synonymy under *C. tetrapterum* var. *obovale* with some hesitation. The key character used to separate this species was the presence of a submarginal vein (although this is obscured by the submarginal thickening in most specimens of *C. tetrapterum* var. *obovale* and is thus not obvious, it is sometimes visible). Ridley (1922, *loc. cit.*) noted that *C. griffithii* was common on the riverbanks in Pinang, Malacca, Johore, and Singapore; I am not sure to what species he was referring, although it may have been *C. tetrapterum* sensu lato.

101. *Calophyllum rupicola* Ridley, Trans. Linn. Soc. Bot. II. 3: 278. 1893 ("C. rupicolum"), Fl. Malay Penin. 1: 182. 1922; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 346. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 168. 1973. TYPE: Malaya, Pahang, Tahan River, anno 1891, Ridley 2636 (holotype, SING; isotypes, BM, K).

*C. rupicola* Ridley var. *elatum* T. C. Whitmore, Gard. Bull. Singapore 26: 270. 1973, *pro parte, typo haud incluso*, Tree Fl. Malaya 2: 168. 1973, *pro parte*.

Shrub or tree 0.6–6 meters tall; bark unknown; latex yellow to cream.

Twigs slightly flattened, 0.5–2(–3.5) mm. across, strongly 4-angled, drying brown,  $\pm$  puberulent when young; axillary innovations usually lacking basal scars; internodes 0.5–3.5 cm. long; uppermost pair of axillary buds rounded, to 1 mm. long, spreading, not very conspicuous; terminal bud plump, 1.2–4.5 mm. long, with short, grayish to brownish, adpressed indumentum (hairs, FIGURE 31, o, p), underdeveloped internode to 2.5 mm. long. Petiole 2–4(–8) mm. long, concave above, convex below, glabrescent; lamina elliptic to elliptico-oblong (rarely oblong), (1.9–)3–9(–16) by (0.35–)0.75–3(–4.7) cm., acute to acuminate at apex, narrowly cuneate at base, rather broadly and distantly undulate but slightly recurved at margin, coriaceous to thinly coriaceous, drying dark brick color to umber above and umber to fulvous below,  $\pm$  persistently puberulent on midrib above and below (on entire lower surface), the midrib above narrowing gradually from base, raised, 0.15–0.25 (–0.3) mm. wide at midpoint, below raised, striate, the venation apparent to subobscure above, usually subobscure below, raised, latex canals often impressed, (6 to) 12 to 15 veins/5 mm., angle of divergence 50–60(–80)°. Inflorescences from foliate axils, with (1 to) 3 to 9 flowers, unbranched, the axis 0.25–1(–2.2) cm. long, strongly angled, puberulent, lowest internode 2–5(–7) mm. long, upper internodes if present often very short; bracts ovate, ca. 1.8 mm. long, densely puberulent below; pedicels 1.5–7 mm. long, puberulent to glabrous, strongly angled even in fruit. Flower (?) hermaphroditic; tepals 4 or 6, the outer pair ovate, 2.7–3 by ca. 2.2 mm., with strip of puberulence down back, the inner ones elliptico-oblong, 4–5 by 1.5–2.6 mm.;

stamens ca. 50, the filaments to 3 mm. long, the anthers subelliptic to oblong, 0.4–1 mm. long,  $\pm$  rounded at apex; ovary 1.2–1.6 mm. long, style 2–2.7 mm. long, stigma unknown. Fruit ellipsoid to subspherical, 0.8–1.2 cm. by 0.6–0.95 mm., usually strongly apiculate, drying brown, wrinkled when immature, later smooth; outer layer not detaching cleanly from stone, very thin, obscured by large air spaces developed; stone spherical to ellipsoid, 7–10.5 by 6–8.5 mm., rounded at apex, the walls ca. 0.15 mm. thick, smooth, unmarked; (?) spongy layer.

DISTRIBUTION. Northeastern Malaya and Peninsular Thailand; a form in eastern Malaya and scattered in Sumatra (MAP 33).

SELECTED SPECIMENS SEEN (all specimens of the variant seen cited). **Thailand:** Peninsula, Narathiwat, Waeng, *Sangkhachand et al.* 1067 (BKF, L). **Malaya.** **KELANTAN:** Kuala Rek, *SFN* 10175 (A, SING); Chan [n]ing Woods, *Ridley s.n.*, 30 Jan. 1917 (var.) (K); Bukit Baka, Machang, 457 m., *Shah & Shukor* 3163 (SING); Ulu Sat F.R., 210 m., *FRI* 2951 (K, KEP, SING); G. Stong, 762 m., *FRI* 12416 (K, KEP); Mak Meh Nak, *KEP* 37975 (SING). **TRENGGANU:** Mandi Angin, S. Loh near Kuala Datok, 30 m., *FRI* 8952 (K, KEP, L); Ulu Telamong, Bukit Rambai F.R., *FRI* 11401 (var.) (KEP, L, SAN, SING); Bukit Bauk F.R., *KEP* 76091 (?) (A, SING); Sungei Trengganu, near Jeram Galong, *FRI* 8350 (A, K, KEP, L, SAR, SING); compartment 90, Gunong Tebu F.R., 150 m., *FRI* 2513 (KEP, L, SAR, SING); Ulu Brang, near Kuala Lallang, 90 m., *FRI* 12526 (A, K, KEP, L, SING); **PAHANG:** between Sungei Puteh and Teku Taman Negara, *Soepadmo* 865 (A, BO, K, KEP); near Kuala Tahan, Jeram Panjang, *Shah & Noor* 2039 (A, C, CANB, KEP, L, SING); Poko Kamancheng, *Ridley s.n.*, Nov. 1920 (K); Taman Negara, Sungei Tahan, *Shah & Shukor* 2670 (C, KEP, SING); G. Tahan, *Wong & Wyatt-Smith* 22 (KEP); Sungei Tembeling, 90 m., *Stone* 10889 (KLU); between Kuala Tahan and Kuala Trengganu, 100–200 m., *Chin* 1318 (K, KLU, L); Tahan woods, Kuala Teku, 120 m., *FRI* 4762 (K, KEP, L, SING); Rompin, *KEP* 15461 (var.) (KEP); Lesong F.R., *Ahmad & Shukor* 448 (var.) (C, KEP, SING); Bukit Cheras, ca. 180 m., *Henderson s.n.*, 22 Oct. 1931 (var.) (SING); Bukit Goh F.R., *KEP* 3132 (var.) (SING). **JOHORE:** G. Blumut, Upper Camp, 549 m., *FRI* 8824 (var.) (A, KEP, L, SAR, SING); Sungei Kayu Ara, Mawai-Jemaluang Road, *Corner s.n.*, 9 Feb. 1935 (var.) (SING); Panti F.R., 6 m., *Stevens et al.* 104 (var.) (A), 104A (var.) (A). **Sumatra.** **SELATAN:** Toelang Bawang nabij Talung Batoe, 30 m., *Idenburg* 44 (var.) (BO); Moeko2, Lalang Loeas, 50 m., *bb* 23555 (var.) (BO, L, MO). **UTARA:** Padang Sidempuan, near village Grunggan, 150 m., *Kostermans* 22040 (var.) (A, L).

ECOLOGY. Usually rheophyte growing on banks of rivers and streams, hence liable to be inundated. Normally shrub less than 2.5 m. tall, but *FRI* 8350 apparently taken from tree 8 m. tall with trunk initially creeping along ground. Sometimes in forest away from streams—then small tree (e.g., *FRI* 2516). Variant typically tree (see below). 30–762 m. alt., the variant 6–550 m. alt. Flowering January, April, May, July, August, and November; fruiting January, February, April, and June to October (ripe fruit yellowish or orange).

The typical form of *Calophyllum rupicola* can be characterized by its often rather small, (narrowly) elliptic, subcoriaceous lamina that dries grayish brown above and golden brown below, with the latex canals on both surfaces often

impressed. The buds along the twigs are often markedly supra-axillary. Its inflorescence is short and congested, with the upper internodes often shorter than the lowest one; both the inflorescence axis and the short pedicels are strongly angled. The small fruits are apiculate, sometimes markedly so, and are reported to be yellow to orange when ripe. The epithet *rupicola*, "rock-dweller," emphasizes the fact that this species is usually found growing among rocks by rivers and streams.

When *Calophyllum rupicola* grows away from streams, it looks rather different from the typical rheophytic form of the species; it is larger in all its parts and has a broader leaf blade. However, the two extremes are connected by intermediates. Scars at the bases of the innovations are found in the smaller, profusely branched rheophytic forms. Some of the specimens cited as *C. rupicola* var. *elatum* by Whitmore (*loc. cit.*; *FRI* 2513, 2516) belong to the forest form (see also the discussion after *C. tetrapterum*).

*Sangkhaachand et al.* 1067, from Peninsular Thailand, has stout twigs and large leaves (the upper limits of the measurements given) and was taken from a tree 10 meters tall. In such characters as inflorescence and color and venation of the dried leaf, it agrees with the typical form of *Calophyllum rupicola*. *KEP* 76091 was included in *C. rupicola* variety by Henderson and Wyatt-Smith (*loc. cit.*). It is retained in *C. rupicola* with hesitation: the specimen is superficially like *C. dasypodum* but differs in hair type and leaf. The thick outer layer of the immature fruit also invites comparison with *C. dispar*.

The specimens cited above as "var." are perhaps merely an extreme form of the forest-dwelling *Calophyllum rupicola*. They have not been included in the description above and can be characterized as follows.

Shrub 0.5 meters (*Kostermans* 22040) to tree 6(-18) meters tall; inner surface of outer bark brick orange; latex opaque, pale yellow, only tardily becoming sticky. Petiole tending to dry dark brown, contrasting with paler brown twig; lamina elliptic-oblong, (3.5-)7-16.5 by (1.1-)3.2-5 cm., sharply acuminate, acumen (0.3-)0.5-1 cm. long, thinly coriaceous, margin closely and strongly undulate, angle of divergence of venation 65-80°.

In other characters these specimens seem close to *Calophyllum rupicola*: the latex canals of the lamina tend to dry impressed, the inflorescence axis and the short pedicels are strongly angled, and—according to field notes on *Kostermans* 22040—the fruit is yellow. The variant of *C. rupicola* grows with *C. tetrapterum* in the Panti Forest Reserve, Johore (*C. rupicola*—*Stevens et al.* 105, 105A; *C. tetrapterum*—*Stevens et al.* 104), and the two are clearly different taxa. The inner surface of the outer bark of *Calophyllum rupicola* variant was brick orange in color and the latex opaque, pale yellow, and fluid; the margin of the lamina was undulate; and the very young plant was arched, with the stem initially plagiotropic. These bark characters are at most unusual in *C. tetrapterum* (the inner surface of the outer bark of *C. tetrapterum* in the Panti F.R. was brownish, and the latex was clear yellow and sticky). I have never seen *C. tetrapterum* with undulate margins to the leaf blades, nor have I seen young plants growing other than erect. Clearly, it will be of considerable interest to study germination and the young plant of *C. rupicola* *sensu stricto*.

*Calophyllum rupicola* is apparently related to *C. pisiferum*, which in Thailand (although apparently not in Malaya) is also sometimes a rheophyte, and to the variable *C. tetrapterum*. *Calophyllum pisiferum* has stouter twigs, better-developed indumentum, and leaf blades that are less sharply pointed at the apex and that dry browner. *Calophyllum tetrapterum* is usually quite different from *C. rupicola*, having broader leaf blades with clearer, more distant venation and a margin that dries paler than the rest of the blade; the blade itself rarely dries golden brown below, and the latex canals are usually  $\pm$  invisible. The inflorescence and pedicels are longer and are not so clearly angled. However, a few specimens referable to *C. tetrapterum* at least superficially approach *C. rupicola*. *FRI 10956* (610 m., SE. Pahang) is like *C. rupicola* in inflorescence type, flower size, and—to a certain extent—color of the dried leaf; it was taken from a tree 15 meters tall. *FRI 13630* (425 m., Kedah) is perhaps like *C. rupicola* in fruit type, although in other respects it is not similar.

Careful field observations of the *Calophyllum rupicola*-*C. pisiferum*-*C. tetrapterum* group as a whole in Malaya and Thailand are needed to assess the significance of all the variation discussed.

102. ***Calophyllum pisiferum*** Planchon & Triana, Ann. Sci. Nat. Bot. IV, 15: 294. 1862; Ridley, Fl. Malay Penin. 1: 184. 1922; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 345. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 172. 1973. TYPE: Malaya, Malacca, Nov. 1837, *Gaudichaud 86* (lectotype, G; isotype, P). FIGURE 32, k, l.

*C. retusum* Wall. ex Choisy var. *cambodgense* Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 321. 1910; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 275. 1943 (incl. *C. sangkhae*); Pham, Cây-Cỏ Miền Nam Việt-Nam. ed. 2, 2: 303. 1970. TYPE: Cambodge, Dom-Phaong, *Hahn 86* (holotype, P).

*C. retusum* Wall. ex Choisy var. *cochinchinense* Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 321. 1910; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 275. 1943; Pham & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. *bang 62bis D.* 1960; Pham, Cây-Cỏ Miền Nam Việt-Nam. ed. 2, 2: 303. *fig.* 1970. TYPE: Cochinchine [Vietnam], Ti Tinh, *Thorel 1395* (lectotype, P; isotypes, B, K).

*C. sangkhae* Craib, Kew Bull. 1925: 18. 1925, Fl. Siam. Enum. 1: 122. 1931. TYPE: Siam [Thailand], Surin, Sangka, ca. 300 m., 4 Jan. 1924, *Kerr 8283* (holotype, K; isotype, P).

*C. motleyi* Ridley, Kew Bull. 1938: 122. 1938; Masamune, Enum. Phanerog. Born. 476. 1942. TYPE: Dutch SE. Borneo [Kalimantan], Bangarmassing, *Motley 865* (holotype, K).

*C. retusum* auct., non Wall. ex Choisy; T. Anderson in Hooker f. Fl. Brit. India 1: 272. 1874, *pro parte*; Pierre, Fl. Forest. Cochinch. 1: *pl.* 102. 1885; Vesque, Epharmosis 2: *t.* 25. 1889; King, Jour. Asiatic Soc. Bengal, II, 50: 176. 1890, *pro maiore parte*.

*C. amoenum* auct., non Wall. ex Choisy; Vesque in C. DC. Monogr. Phanerog. 8: 576. 1893, *pro parte*.

*C. rupicola* Ridley variety; M. R. Henderson & Wyatt-Smith, Gard. Bull.

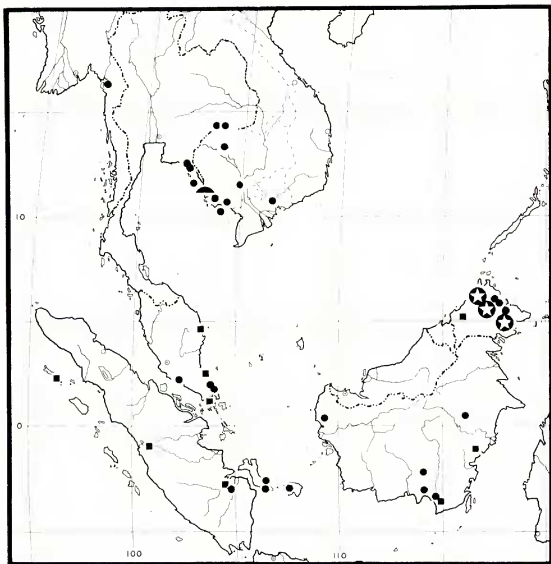
Singapore 15: 347. pl. 27. 1956, *pro parte*.

*C. rupicola* Ridley var. *elatum* T. C. Whitmore; Corner, Gard. Bull. Singapore Suppl. 1: 104. 1978, *pro parte*.

Shrub 0.1 meter to tree 30 meters tall, d.b.h. to 60 cm.; trunk without buttresses, knee roots sometimes present; outer bark yellowish and brownish mottled, or pale yellow, hoop marked or not, somewhat cracked longitudinally or lenticellate, the inner surface dirty greenish and dull straw mottled; under bark dark red; inner bark dark red; latex opaque yellow, sticky (pale yellow—*SAN 51649*; bright yellow—*Motley 865*); sapwood dirty white or pale ochre; heartwood red and beautifully marked, or light brown.

Twigs slightly to strongly flattened, 1.5–2.5 mm. across, sharply 4-angled, drying grayish brown to blackish, shortly and usually persistently tomentose; axillary innovations lacking basal scars or not; internodes 0.3–3 cm. long; uppermost pair of axillary buds rounded, less than 0.7 mm. long,  $\pm$  spreading, inconspicuous; terminal bud plump, 2–4.5 mm. long, with adpressed to spreading, brown indumentum (hairs, FIGURE 31, f, h–k), underdeveloped internode absent. Petiole 2.5–5 mm. long, deeply concave above, convex below, subpersistently short-tomentose, especially below; lamina ovate to oblong or (narrowly) elliptic, (1.9–)3–7.5(–9.5) by (0.9–)1.6–3.2(–4) cm., rounded to acute at apex, broadly rounded (shallowly cordate) to narrowly cuneate at base, almost flat to distantly undulate and at most slightly recurved at margin, thinly coriaceous to coriaceous, drying sepia to olivaceous above and umber to sabelline below, subpersistently puberulent on midrib above and especially below (soon glabrescent), the midrib above rather narrow at base, further narrowing gradually, sharply raised ( $\pm$  depressed at first), 0.15–0.35 mm. wide at midpoint, below raised, striate or rounded, the venation on both surfaces  $\pm$  apparent, raised, latex canals sometimes impressed, (3 to) 5 to 8 (to 11) veins/5 mm., angle of divergence 55–75°. Inflorescences from (de)foliate axils along stem, with 5 to 15 flowers, unbranched, the axis (0.2–)1–3.5 cm. long, short-tomentose at base, otherwise  $\pm$  puberulent, lowest internode to 5(–10) mm. long, next internode often shorter than those at end of inflorescence; bracts ovate to subelliptic, 2.2–3 by 0.8–1.5 mm., deciduous; pedicels 0.3–1.3(–1.8) cm. long, glabrous or almost so, slender and 4-alate. Flower (?) hermaphroditic; tepals 4, the outer pair broadly elliptic to ovate, 3.5–5 by 1.5–3 mm., sometimes with short hairs on back near apex, the inner ones elliptic to obovate, 5–6 by 2–4(–5) mm.; stamens 30 to 70, the filaments to 3.5 mm. long, the anthers elliptic, 0.4–0.6 mm. long, (sub)retuse at apex; ovary 1.2–1.3 mm. long, the style 2.5–3.5 mm. long, the stigma expanded, 0.3–0.4 mm. across. Fruit spherical to ellipsoid, 6–9 by 5.5–7 mm., sharply apiculate, drying sharply wrinkled, smooth when quite ripe, brown; outer layer not detaching cleanly from stone, ca. 0.2–0.5 mm. thick, air spaces developing; stone spherical to ellipsoid, 5.5–8 by 5–6 mm., rounded at apex, the walls less than 0.1 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southern Vietnam to Borneo, scattered, excluding Java (MAP 35).



MAP 35. Distribution of *Calophyllum pisiferum* (circles), *C. dispar* (squares), *C. lineare* (half-circle), and *Calophyllum* sp. 98 (stars in solid circles) in Southeast Asia-Malesia.

SELECTED SPECIMENS SEEN. **Burma:** Martaban, *Griffith s.n.* (BM, C, FI, G, GH, M, P). **Vietnam:** flumen Saigon prope Beu Chuc, *Pierre 3648* (P); Phu Thoc, Sinus Siamica, *Pierre 3648* (P); Cai Cong, *Thorel 1395* (P). **Cambodia:** Koh Kong, presqu'île Smach, *Vidal 5000* (L, P); près de Thmar Banf, 400 m., *Martin 1495* (P); route de Srê Ambel, *Martin 1017* (P); Kampot, cascade Tuk Sap, *Martin 1133* (P); Pnomh Penh, *Béjaud 458* (K, P); Kg. Thom, Kg. Loai, *Béjaud 215* (P); Siem Reap, Phnom Kulen, 250 m., *Martin 1298* (P). **Thailand:** Chantaburi, Makam, Ban-ang, *Chit 161* (BKF); E. of Makam, 100 m., *Sorensen et al. 464* (C); Krat, Kao Saming, *Kerr 9435* (BM, C, K, L, P); Kao Kuap, 700 m., *Kerr 17774* (A, BM, C, L, P); SE. Ko Kut, *Charoenphol et al. 5097* (AAU); Trat, Kaw Kut, 20 m., *Smitinand 5723* (BKF). **Malaya.** MALACCA: sine loco, *Griffith s.n.* (coll. *Lemann*) (BM, BO, G, GH, K, L, MO, P). JOHORE: Mawai, "low" alt., *SFN 34706* (?) (BO, LAE, SING), *SFN 34747* (?) (A, L, SING); Kangka Sedili Ketchil, *Corner s.n.*, 17 June 1934 (?) (SING). **Sumatra and adjacent islands.**

SELATAN: Meranjat, Sebetan, *Teysmann*, HB 3451 (BO). BANGKA: Lobok Besar, 5 m., *bb* 34028 (L, SING); Rias, 10 m., *bb* 15401 (BO, L). BELITUNG: Tandjong Pandan, *Teysmann* s.n. (BO). BORNEO. SABAH. Labuk & Sugut: Sungei Mangkanyoh, N. of Klagan R., *SAN* 51649 (SAN); Lower Sugut, *SAN* 27622 (SAN). Sandakan: Ulu Dusun F.R., 2 m., *Stevens et al.* 354 (A). Kinabatangan: opposite Gabang Camp, *SAN* 23096 (A, KEP, SAN, SAR, SING). KALIMANTAN. Timur: Central Kutei, Belajan R., near Long Bleh, *Kostermans* 10292 (A, BO, G, K, LAE, SING). Selatan: km. 14 Bandjarmassin en Martapoera, Toelong Redjo, *Polak* 419 (BO); d. Kambat, *Korthals* s.n. (L); Tabanio, Tanah Laut, *Civiel Bestuur* s.n. (BO); Kaiteng, Sungei Sekunyir, Kumai, *Anderson* (1975) 1 (BO). Tengah: Djoeking Koempai (Koelo Kapaeos), *bb* 2180 (BO); Beneden Dajak, Mangkoe-top, *bb* 2957 (BO). Barat: Mandor, 50 m., *Dunselman* 101 (BO); Pontianak, sine loco, *bb* 16373 (BO, K, L, SING, U).

ECOLOGY. On SE. Asian mainland: shrub or small tree frequently on stream banks, usually rocky places (narrower-leaved specimens typically rheophytes), also on sandy soil; 20–700 m. alt. Flowering October and January (flower scented); fruiting November to February (ripe fruit apparently orange to light chestnut, although reported by Pierre (*loc. cit.*) to be white).

In Malesia: in peat swamps, periodically inundated flat land, or riverine forest; below 50 m. alt. Flowering November, January, and March (flower scented; corolla reported to be pink (*Anderson* (1975) 1)); fruiting March and April (fruit yellow and sour, or orange).

GERMINATION AND YOUNG PLANT. The radicle probably breaks through the stone to one side of the base. The seedling is small (less than 7 cm. tall), and has two or three pairs of leaves separated by internodes ca. 1 cm. long. During subsequent growth, the internodes produced are successively longer, the plant grows erect, and the terminal bud is functional. (*Stevens* 353, from Sabah.)

LOCAL USES. A decoction of the bark is used to cure diarrhea (Cambodia); the branches are used for house and boat poles (Thailand).

*Calophyllum pisiferum* can be recognized when sterile by its sharply four-angled twigs that are often persistently short-tomentose. Its rather small leaf blades vary considerably in size and sometimes also in shape on one specimen and are sepia above in older specimens; their venation is relatively distant and prominent. Internode length increases toward the top of the inflorescence axis, and the axis is usually covered with indumentum for its entire length. The pedicels are slender, and the flowers always have four tepals. The fruits are small and wrinkled and have a thin outer layer; they look rather like dried, wrinkled peas (*pisiferum* means "pea-bearing").

*Calophyllum pisiferum* is quite a variable species and has a disjunct distribution<sup>16</sup> (MAP 35), especially in mainland Southeast Asia. Its delimitation has been troublesome. With only one exception, the specimens from this area were collected from shrubs or small trees less than 9 meters tall (*Smitinand* 5723 is reported to have been taken from a tree up to 30 meters tall—probably

<sup>16</sup>The single specimen from Burma, *Griffith* s.n., may be incorrectly labeled.

an error) often growing alongside rivers. The leaf blades vary from narrowly elliptic to ovate. The Malasian specimens were taken from medium-sized to fairly large (to 30 m.) trees generally growing in wet places; variation in lamina shape is less, and the blades are usually more or less ovate. In at least some specimens from West Malesia (e.g., *bb* 36028, *Kostermans* 10292), the axillary innovations have basal scars, but such scars are uncommon in specimens from the Southeast Asian mainland (although they occur on some innovations in *Charoenphol* 5106). Nevertheless, *C. pisiferum* is broadly circumscribed because in other vegetative details, hair type, flowers, and fruit, all specimens are similar.

*Calophyllum lineare* is very close to *C. pisiferum* and may be merely an extremely narrow-leaved form of it. There are other, perhaps minor, differences between the taxa: *C. lineare* has slender twigs that dry grayish brown, and the stone is separated from the base of the fruit by a fibrous zone 1–2 mm. long. Such a fibrous zone is much less well developed in *C. pisiferum*. The leaf blades of *C. lineare* are more or less coriaceous, but so are those of such specimens of *C. pisiferum* as *Martin* 1133 and *Kerr* 17774. Further collections of *C. pisiferum* and *C. lineare* from Cambodia and Thailand may lead to a reduction in rank of the latter, but such a reduction is at present premature. The type (and only) specimen of *C. lineare* cannot be satisfactorily accommodated in *C. pisiferum*.

*Calophyllum pisiferum* is also related to *C. dispar*; for the differences between the two, see *C. dispar*. *Calophyllum rupicola* and *C. tetrapterum* are also somewhat similar to *C. pisiferum*; both these species are variable, and *C. rupicola* is also a rheophyte. The indumentum of both species is less prominent than that of *C. pisiferum*. *Calophyllum rupicola* often has denser venation, the latex canals are frequently (rather than rarely) impressed, the buds along the stem are often supra-axillary, the fruit is ovoid-elliptic, and the apex of the leaf blade is acute to acuminate. When dry the leaf is characteristically greenish-grayish brown above and golden brown below, rather than the sepia color of *C. rupicola*. The flowers and the fruits of *C. tetrapterum* are larger than those of *C. pisiferum*, and the upper internodes of the inflorescence axis are usually not markedly longer than the lower ones. The leaf blade generally dries a different color, and the margin is more or less recurved. *Nitrasirirak* 206 (probably *C. tetrapterum*, from S. Thailand) has the inflorescences of *C. pisiferum*.

The specimens from Johore cited above are included with some hesitation; they were included in an unnamed variety of *Calophyllum rupicola* by Henderson and Wyatt-Smith (*loc. cit.*; for *KEP* 76091, also placed there, see *C. rupicola*). They differ somewhat from more typical *C. pisiferum* in having puberulent indumentum only near the base of the inflorescence and a coriaceous lamina with more or less impressed latex canals. However, in other characters they agree with *C. pisiferum*, and the field notes attached to *Corner s.n.* suggest that the bark characters are similar to the trees of *C. pisiferum* seen in Sabah, although the plants are somewhat smaller (less than 10 m. tall).

The specimen of *Gaudichaud* 86 at Geneva is designated as the lectotype



of *Calophyllum pisiferum*. Planchon and Triana cited another specimen, "Griffith [*Kew dist.* 876] in herb. Planchon, ex herb. Hook.," also collected in Malacca. Of the two syntypes of *C. retusum* var. *cochinchinense* (Thorel 1395 and 1407), Thorel 1395 at Paris is designated as the syntype.

The type specimens of *Calophyllum motleyi* and *C. retusum* var. *cochinchinense* are good matches with the type of *C. pisiferum*. The type specimens of *C. retusum* var. *cambodgense* and *C. sangkhae* represent a rather long-leaved variant common in the Cambodia-Thailand area.

103. *Calophyllum lineare* Kostermans, *Adansonia*, II. 13: 333. *pl.* 1, 1, 2. 1973. TYPE: Cambodia, Kah Kong, Khbal Kah, 12 Feb. 1970, Martin 1783 (holotype, P; isotypes, L, P).

Shrub 1.5 meters tall; bark not known.

Twigs slightly flattened, 0.7–1 mm. across, 4-angled, drying grayish brown, subpruinose, puberulent when young; axillary innovations lacking basal scars; internodes 0.3–1.5 cm. long; uppermost pair of axillary buds rounded, ca. 0.7 mm. long, suberect; terminal bud conical, 1.8–2.4 mm. long, with short, tomentose, brown indumentum (hairs, FIGURE 31, s), underdeveloped internode absent (to 1 mm. long). Petiole 2–2.5 mm. long, concave above and convex below, glabrous when mature; lamina narrowly elliptic, 1.8–6 by 0.18–0.6 cm., cuneate to rounded at apex, narrowly cuneate at base, not undulate but slightly recurved at margin, coriaceous, drying umber to sepia above and below, glabrous when mature, the midrib above narrowing gradually from base, flat to slightly raised, 0.08–0.14 mm. wide at midpoint, below raised,  $\pm$  rounded, the venation above and below subapparent, slightly raised, 7 to 11 veins/5 mm., angle of divergence 45–50°. Infructescences from foliate axils, with scars of 3 to 7 flowers, unbranched, the axis 0.8–2 mm. long, sparsely tomentose toward base, lowest internode 3–7 mm. long; bracts unknown, their scars sometimes 2 mm. below pedicel they subtend; pedicels 1–1.5 cm. long, glabrous. Flower unknown; tepals probably 4 (from scars). Fruit broadly ovoid, 8–10 by ca. 7 mm., apiculate, drying russet, smooth, when submature obovoid and sharply wrinkled; outer layer not detaching cleanly from stone, ca. 0.3 mm. thick, disorganized by air spaces; stone ellipsoid, ca. 8 by 6.3 mm., rounded at apex, with fibrous zone ca. 2 mm. long at base, the walls ca. 0.1 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Cambodia (Map 35); known only from the type locality.

ECOLOGY. Rheophyte with narrow leaves, among rocks at edge of river. Fruiting in February; fruit orange.

LOCAL USE. The fruit is used as bait for fish.

*Calophyllum lineare* can be recognized by its narrowly elliptic, coriaceous leaf blades, short terminal bud, and small fruits borne on slender pedicels. The specific epithet *lineare* alludes to the shape of the leaf blades.

*Calophyllum lineare* is closely related to *C. pisiferum*; for the differences

between the two species, see *C. pisiferum*. It also shows a superficial similarity to the more or less linear-leaved specimens of *C. nodosum* from Brunei. However, *C. nodosum* has a shorter terminal bud with much less conspicuous indumentum, axillary innovations with basal scars, and a midrib impressed on the lower surface of the lamina but raised and continuous with the leaf surface on the upper.

Kostermans (*loc. cit.*) noted that the lamina of *Calophyllum lineare* was densely and finely marked by pores on both surfaces. I have seen pores (stomata) only on the lower surface.

104. *Calophyllum dispar* P. F. Stevens, sp. nov.

FIGURE 32, m-o.

*C. molle* auct., non King; H. Keng, Gard. Bull. Singapore **28**: 244. 1976; Corner, Gard. Bull. Singapore Suppl. **1**: 104. 1978.

A *Calophyllum* pisifero, quo aliter simile est, in gemma terminali (3.5-)4.5-7 mm. longa (versus 2-4.5 mm. longa), lamina 6-15 cm. longa et 1.8-5 cm. lata (versus (1.9-)3-7.5(-9.5) cm. longa et (0.9-)1.6-3.2(-4) cm. lata), et fructu strato exteriori (0.5-)1-1.5 mm. crasso (versus 0.2-0.5 mm. crasso), differt.

Tree 15-18 meters tall, d.b.h. to 30 cm.; trunk without buttresses; outer bark yellowish to grayish, smooth or with diamond-shaped fissures; inner bark pinkish to brown; latex yellow or yellowish.

Twigs slightly flattened, 1.5-3 mm. across, 4-angled (with 4 additional raised lines), drying blackish, subsersistently brown-tomentose or gray-brown-puberulent; axillary innovations sometimes with basal or subbasal scars; internodes 0.5-3.5 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, suberect, inconspicuous; terminal bud plump, (3.5-)4.5-7 cm. long, with brown, tomentose to subappressed indumentum (hairs, FIGURE 31, l, r), underdeveloped internode absent. Petiole 4-6 mm. long, broadly and deeply concave above and convex below, transiently to subsersistently puberulent to tomentose; lamina elliptic to ovate, 6-15 by 1.8-5 cm., obtuse to short-acuminate at apex, cuneate to broadly rounded at base, strongly and closely undulate but at most slightly recurved at margin, coriaceous, drying bay to umber above, often with grayish covering, and brick to umber below, transiently puberulent to persistently tomentose on midrib below (scattered hairs over entire surface), the midrib above gradually to rather quickly narrowed, raised, 0.2-0.3 mm. wide at midpoint, below raised, striate (rarely angled), the venation apparent on both surfaces, raised, 5 to 9 (to 11) veins/5 mm., angle of divergence (65-)75-80°. Inflorescences from foliate axils along twigs, with 7 to 21 flowers, unbranched (rarely with 3-flowered branches ca. 3 mm. long), the axis 0.7-5.2 cm. long, puberulent to subtomentose (glabrous toward apex), lowest internode 2-4 mm. long; bracts subovate, to 6 mm. long, deciduous; pedicels 3-6 mm. long, glabrous or almost so, in fruit to 10 mm. long, usually obviously incrassate, to 2 mm. across. Flower (?hermaphroditic; tepals 4, sometimes glabrous, narrowly ovate, 3-4 by 1.5-2 mm., outer pair sometimes tomentose, inner pair sometimes with tuft of hairs at apex; ovary ca. 1 mm. long, the style 2.2-2.5 mm. long, the stigma

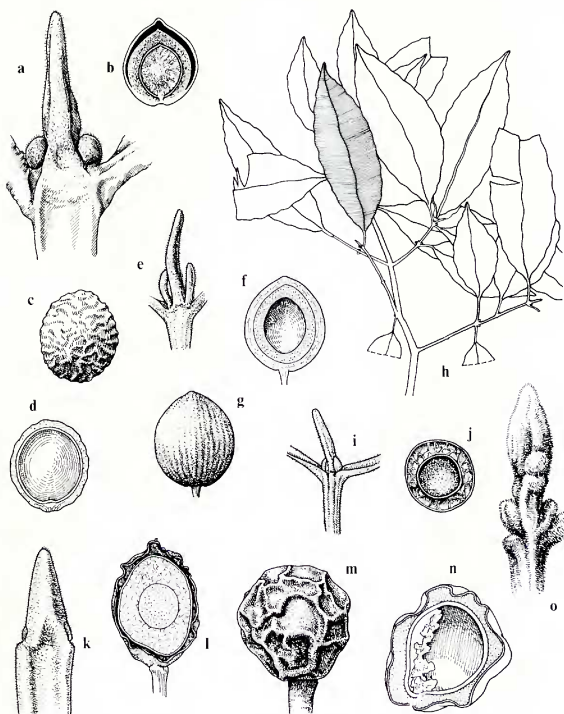


FIGURE 32. a, b, *Calophyllum incumbens*: a, Kostermans 12813, terminal bud,  $\times 6$ ; b, BRUN 327, fruit, longitudinal section,  $\times 1.5$ . c, d, *C. clemensorum* (Clemens 35038), fruit,  $\times 1.5$ : c, from outside; d, longitudinal section. e-g, *C. banyengii* (Stevens et al. 296). e, terminal bud,  $\times 3$ ; f, g, fruit,  $\times 1$ : f, longitudinal section; g, from outside. h-j, *C. dioscurii*: h, FRI 19292, habit,  $\times 0.5$ ; i, FRI 19292, terminal bud,  $\times 3$ ; j, FRI 6773, fruit, longitudinal section,  $\times 1$ . k, l, *C. pisiferum* (Griffith s.n.): k, terminal bud,  $\times 6$ ; l, fruit, longitudinal section,  $\times 3$ . m-o, *C. dispar* (SFN 37715). m, n, fruit,  $\times 3$ : m, from outside; n, longitudinal section. o, terminal bud,  $\times 3$ .

peltate, ca. 0.6 mm. across, obscurely radiate. Fruit spherical to broadly ellipsoid, 7–10 by 7–9 mm., apiculate, drying pruinose-brown, strongly wrinkled; outer layer not detaching cleanly from stone, (0.5–)1–1.5 mm. thick, at first compact, air spaces developing under skin; stone spherical, 4.5–7.5 by 4.5–7 mm., rounded at apex, the walls 0.1–0.2 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Singapore, Mandai Road, 29 July 1940, *SFN 37715* coll. *Kiah* (holotype, A; isotypes, BM, BO, KEP, SING).

DISTRIBUTION. Malaya to Borneo, scattered, excluding Java (MAP 35).

ADDITIONAL SPECIMENS SEEN. **Malaya.** TRENGGANU: 55 m. [88 km.] S. Kuantan toward K. Trengganu, *Phytochem. Survey Malaya 505* (L, SING). PAHANG: Rompin, Bukit Serdang State Land, *KEP 29864* (KEP). **Singapore.** W. end of Seletar Reservoir, upper Mandai, *SFN 39698* (BO, E, K, SING), *Sinclair 7727* (E), 15 m., *Stevens et al. 716* (A). **Sumatra and adjacent islands.** SELATAN: Lematang Ilir, 75 m., *T 3 P 894* (*T[horenaar]* 894) (BO, L, LAE, P), *T 3 P 859* (*T[horenaar]* 859) (BO). BARAT: Solok, Loeboek Soelasik, 1150 m., *bb 6544* (BO). ATJEH: Is. Simaloer, Landschap Tapah (Defajan), *Achmad 1483* (BO, L), *1664* (BO, L), *1751* (BO, L). **Borneo.** SABAH. Keningau: Mile 23½, Tulid Road, Sook Plain, *SAN 55545* (SAN). KALIMANTAN. Timur: peak of Balikpapan, G. Beratus, 700 m., *Kostermans 7592* (A, BO, K, L, LAE, P, SING). Selatan: Bandjermasin, *Dachlan 20b* (BO). Sine loco (?Sumatra), *Buwalda 6751* (BO, K, L).

ECOLOGY. In swamp forest (*SFN 37715*); on sandy, blackish soil (*SAN 55545*); on sandstone (*Kostermans 7592*); 15–1150 m. alt. Flowering July, October, and November; fruiting February, July, August, and November.

*Calophyllum dispar* can be recognized by its plump, usually tomentose terminal bud; its slightly flattened, strongly angled, and often tomentose twigs; and its medium-sized lamina with a short petiole and with the venation on both surfaces clear and relatively distant. The inflorescence axis is strongly four-angled, and the flowers have four tepals. The ripe fruits are small (1 cm. or less long) with the outer layer relatively very thick ((0.5–)1–1.5 mm.). The epithet *dispar* was chosen to emphasize the disparity in size between the medium-sized leaf blades and the small fruits.

The closest relative of *Calophyllum dispar* is *C. pisiferum*, the two species being separable by the characters given in the diagnosis. Both *C. pisiferum* (at least in Malesia) and *C. dispar* (at least in Singapore) may grow in swamp forest, and apart from the characters given above, the two are very similar. More collections of both species in Malesia are needed to understand the relationship between them—it is possible that the two taxa are only varietally distinct.

Of the specimens of *Calophyllum dispar* cited above, those from Malaya (Trengganu), Singapore, and Borneo have similar tomentose indumentum on twigs, midrib of the lamina (often a few hairs persist on the lower surface of the lamina), and at least the lower part of the inflorescence axis. Specimens from Sumatra and Malaya (Pahang) have less well-developed, more or less

puberulent indumentum, and there is also a tendency for the midrib to narrow more gradually from the base of the blade. Variation in hair type is considerable (FIGURE 31, 1, r); some hairs in the tomentose form have only a few cells, yet are similar in size to the more common hairs with many more cells.

*SFN 37715* was included in *Calophyllum molle* by Henderson and Wyatt-Smith (1956) and subsequent authors, albeit with considerable hesitation. Although the distribution of indumentum on the vegetative parts of *C. molle* and *C. dispar* is similar, they differ in many other characters (the ovary of *C. molle* is densely pubescent, the leaf blade has much closer venation, and the fruits are very much larger). *Calophyllum molle* and *C. dispar* are not at all closely related taxa.

105. *Calophyllum incumbens* P. F. Stevens, sp. nov.

FIGURE 32, a, b.

A speciebus aliis *Calophylli* in lamina (per)coriacea elliptica-obovata margine plerumque valde undulata in siccitate saepe supra olivacea infra mellea-cinnamomea, inflorescentiis axillaribus indumento subpuberulo praeditis, floribus cum 8 tepalis paribus exterioribus dorsalibus puberulis, et fructu strato exteriore plerumque 1-1.8 mm. crasso, differt.

Tree 12-30 meters tall, sometimes leaning, d.b.h. to 23 cm.; trunk ridged or with spur roots; outer bark yellowish, gray to brown, or orange, yellow, gray, and fawn mottled, (slightly) fissured; inner bark orange- to red-brown; latex yellow, clear, sticky.

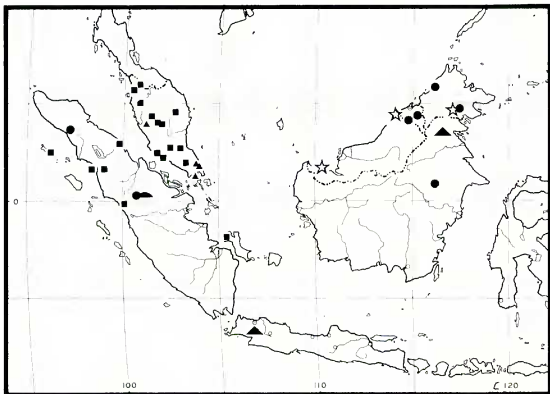
Twigs slightly flattened, 1.5-3.2 mm. across, 4-angled, drying dark brown, transiently farinose-puberulent; axillary innovations lacking basal scars or with single pair near base; internodes (0.5-)1.5-5 cm. long; uppermost pair of axillary buds rounded, 1-1.8 mm. long, spreading; terminal bud plump, 3.6-6.5 mm. long, with brown, puberulent to subfurfuraceous indumentum (hairs, FIGURE 34, a, b; cf. 22, k, l), underdeveloped internode (absent to) 2-3.5 mm. long. Petiole 0.5-1.5 cm. long, broadly and deeply concave above and convex below, puberulent when young; lamina elliptic to obovate, (4.4-)5.5-16.5 by (1.6-)2.8-6 cm., shortly acuminate to acute at apex, cuneate to attenuate at base, strongly undulate and slightly recurved at margin, coriaceous to very coriaceous, drying olivaceous to sepia above and cinnamon to near honey below, farinose-puberulent on midrib below when young, the midrib above gradually narrowed from base, raised to almost flat, 0.15-0.4 mm. wide at midpoint, below raised, slightly striate, the venation apparent above and obscure to subapparent below, raised, latex canals above sometimes slightly impressed, 7 to 17 veins/5 mm., angle of divergence 65-80°. Inflorescences from foliate axils, with 5 to 9 flowers, unbranched, the axis 0.8-4.2 cm. long, puberulent, lowest internode 2-8 mm. long; bracts not known; pedicels (0.3-)0.6-2.2 cm. long, puberulent, usually thickened in fruit, to 2 mm. thick. Flower (?)hermaphroditic; tepals (4 to) 8, the outer pair elliptic to ovate, 4-5 by 3-4 mm., farinose-puberulent on back, especially at base, the next pair broadly ovate to elliptic, 6-7 by 3.5-5.5 mm., the inner ones elliptic to lingulate, (4-)5.5-8 by (0.7-)1.5-3.5 mm.; stamens 115 to (?)250, the filaments to 4.5 mm. long, connate for up to 1.3 mm., the anthers suboblong,

0.6–1.1 mm. long, retuse at apex; ovary 1.5–2 mm. long, the style ca. 3.5 mm. long, the stigma peltate, ca. 0.8 mm. across, (?)2-radiate. Fruit ellipsoid to ovoid, 1.7–2 by 1.4–1.6 cm., apiculate, drying grayish brown, smooth, vinaceous-brown and smooth when young, strongly wrinkled when submature; outer layer detaching  $\pm$  cleanly from stone, (?0.5–)1–1.8 mm. thick, compact except for air spaces developing under skin; stone ellipsoid to subspherical, 0.9–1.35 by 0.7–1.3 cm., rounded at apex, the walls 0.15–0.6 mm. thick, smooth, unmarked; spongy layer (?)thin.

TYPE: Borneo [Kalimantan], West Kutei, Mt. Palimasan near Tabang on Belajan River, 70 m., 9 Nov. 1956, *Kostermans 12813* (holotype, L; isotypes, BO, CANB, K, KEP, L, NY, P, SING).

DISTRIBUTION. Sumatra and Borneo (MAP 36).

ADDITIONAL SPECIMENS SEEN. **Sumatra.** BARAT: Bangkinang, Pedadit, 250 m., *bb 23017* (BO, L). ATJEH: G. Leuser Nature Reserve, G. Bandahara, ca. 25 km. NNW. of Kutatjane, 1100 m., *Wilde & Wilde-Duyfjes 12974* (KEP, L). **Borneo.** BRUNEI: Bukit Suang, ulu Batu Apoi, 610 m., *BRUN 327* (BO, BRI, KEP, L, SAR, SING); R. Ingei-ulu R. Belait watershed, 57 m., *BRUN 158* (BO, BRI, KEP, L, SAR, SING). SABAH. Penampang: Sun Suran Trail, 320 m., *SAN 37777* (SAN). Keningau: Mile 5 Rashna Road, Nabawan, *SAN 83875* (A). Tawau:



MAP 36. Distribution of *Calophyllum dioscurii* (squares, localized specimens; large triangles, incompletely localized specimens), *C. costulatum* (small triangles), *C. aff. costulatum* (half-circle), *C. banyengii* (stars), and *C. incumbens* (circles) in Malesia.

Brassey Range, 770 m., *Stevens et al.* 480 (A). KALIMANTAN. Timur: W. Kutei, Mt. Palimasan near Tabang on Belajan R., 600 m., *Kostermans* 13037 (BO, CANB, K, KEP, L, NY, P, SING).

**ECOLOGY.** Usually in colline forest, (57-)320-1100 m. alt. In Kalimantan, locally abundant in *Agathis* forest on sandy, acid, waterlogged soil; in Penampang, Sabah, in primary (sic) forest on steep hillside with much lapotang (*Gleichenia linearis* C. B. Clarke); in Tawau, small tree on ridge with several other species of *Calophyllum*. Flowering June and December; submature fruit August and September (fruit white (*Kostermans* 13037) or greenish (*SAN* 83875)).

*Calophyllum incumbens* is a rather variable species that nevertheless can readily be recognized by its somewhat short, plump terminal bud and its elliptic-obovate, often very coriaceous and rigid leaf blades that are strongly undulate at the margins and that often dry bicolored (olive above and honey to cinnamon below). The inflorescence axis, pedicels, and at least the bases of the backs of the outer pair of tepals are covered by farinose-puberulent indumentum. The pedicels have become much thickened in four of the five collections that have fruits, and the outer layer of the fruit is (?0.5-)1-1.8 mm. thick. The type specimen was described as coming from a slender, leaning tree—hence the specific epithet (from *incumbo*, “to lean”).

*Calophyllum incumbens* is superficially similar to *C. depressinervosum*: the leaves of the two species dry a similar color, but in *C. incumbens* the venation on the upper surface of the lamina is raised rather than more or less depressed, the axillary innovations lack basal scars, the inflorescence axis is puberulent rather than glabrous, and the outer layer of the fruit is much thicker. *Calophyllum incumbens* is similar to *C. rupicola* in color of the dried specimens and in indumentum distribution, but it is not a rheophyte, the leaves are larger and often thicker, the flowers have eight tepals, and the fruits are larger and have a much thicker outer layer.

The two specimens collected by *Kostermans* from Kalimantan are the most robust and have thicker leaf blades than the others. The specimens from Sabah are somewhat less robust and are intermediate between the specimens from Kalimantan and those from Brunei and Sumatra. Only two specimens with flowers are known, *Wilde & Wilde-Duyffjes* 12974 and *SAN* 37777; the latter specimen has more stamens and smaller anthers. *Wilde & Wilde-Duyffjes* 12974 has vinaceous-brown immature fruits with an outer layer perhaps only 0.5 mm. thick; ripe fruits from Sumatra are needed to confirm the occurrence of the species there.

*FB* 10650, a sterile specimen from the Philippines, dries a similar color to specimens of *Calophyllum incumbens*, but it has branched hairs and probably belongs to the *C. blancoi* complex, which characteristically has hairs of this type.

Immature fruits of *Calophyllum incumbens* are smooth and dry vinaceous-brown. When submature they are wrinkled, but when mature they become smooth again, with air spaces just under the brittle skin.

106. *Calophyllum dioscurii* P. F. Stevens, sp. nov.

FIGURE 32, h-j.

*C. floribundum* Hooker f. Fl. Brit. India 1: 272. 1874, quoad *Maingay*, *Kew dist.* 172.

*Calophyllum* sp. 1. H. Burkill & Haniff, Gard. Bull. Straits Settl. 6: 174. 1930; *Calophyllum* sp. 45, M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 351. pl. 31. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 195. 1973.

A speciebus aliis *Calophylli* in ramulo in siccitate albescenti et petiolo nigrescenti, lamina 3–9(–10.1) cm. longa apice valde acuminata nervis laterali-bus (sub)densis elevatis, et fructu mediocri strato exteriori 1–1.8 mm. crasso, differt.

Tree 15–33 meters tall, d.b.h. to 55 cm.; trunk probably unbuttressed; outer bark grayish yellow, gray, or brown, smooth, with few lenticels, or fissured, sometimes with large, thin scales; inner bark dark brown; latex yellow or dark red (*FRI* 20070), clear.

Twigs slightly flattened, 1.2–1.6 mm. across, obscurely 4-angled, drying whitish to pale yellowish, transiently puberulent; axillary innovations lacking basal scars; internodes 0.5–3(–6.5) cm. long; uppermost pair of axillary buds  $\pm$  acute, to 1.5 mm. long, erect; terminal bud plump to conical, 2.5–5.5 mm. long, with reddish brown, puberulent indumentum (hairs, FIGURE 34, c–g; cf. 34, a), underdeveloped internode absent. Petiole 3.5–6 mm. long, slender, broadly concave above and convex below, glabrescent, drying black; lamina elliptic to ovate (rarely suboblong), 3–9(–10.1) by 1.2–3.4 cm., acuminate (caudate) at apex, cuneate (rarely acute) at base, strongly undulate but not recurved at margin, coriaceous, drying olivaceous to bay above [sometimes shiny] and olivaceous to sepia below, subpersistently puberulent to farinose on midrib below (also above), the midrib above gradually narrowed from base, raised (depressed at first), 0.15–0.25(–0.4) mm. wide at midpoint, below raised,  $\pm$  rounded, the venation apparent on both surfaces, raised, [7 to] 12 to 20 (to 28) veins/5 mm., angle of divergence (55–)70–80°. Inflorescences from foliate axils, with 5 to 7 flowers, unbranched, the axis 4–9 mm. long, puberulent, lowest internode 0.5–3 mm. long; bracts not known; pedicels 4.5–6 mm. long, subpersistently puberulent, in fruit to 2 mm. thick. Flowers known only when old, (?)hermaphroditic; tepals (?)4; stamens (?)numerous, the filaments to 3 mm. long, the anthers oblong-elliptic, ca. 0.5 mm. long, retuse at apex; ovary 1–1.3 mm. long, the style ca. 2 mm. long, the stigma subpetalate, ca. 0.4 mm. across. Fruit spherical, 1.2–1.6 by 1.2–1.5 cm., rounded to apiculate at apex, drying pale pruinose-brown, deeply wrinkled when young,  $\pm$  smooth when older; outer layer not detaching cleanly from stone, 1–1.8 mm. thick, compact when young, large air spaces developing when older; stone spherical to ellipsoid, 0.9–1.1 by ca. 0.9 cm., rounded at apex, the walls 0.3–0.5 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Malaya, Kedah, Ulu Muda F.R., 1000 feet [305 m.], 23 June 1969, *FRI* 11719 coll. Bray (holotype, A; isotypes, K, KEP, L, SAR, SING).



DISTRIBUTION. Malay Peninsula, Sumatra, perhaps also in Java and eastern Borneo (MAP 36).

ADDITIONAL SPECIMENS SEEN. **Malaya.** KEDAH: Ulu Mudah F.R., 457 m., *FRI* 6773 (A, K, KEP, L, SAR), 120 m., *FRI* 11763 (K, KEP, L); Bigia Enggang F.R., 75 m., *KEP* 73776 (KEP); Sungkap F.R., *KEP* 59624 (KEP). PERAK: Bintang Hijan F.R., *KEP* 39154 (K). NEGERI SEMBILAN: Port Dickson, Sungei Menyala F.R., *FRI* 103 (KEP), 45 m., *KEP* 64079 (KEP), 30 m., *KEP* 66585 (KEP, SING); Pasoh F.R., *anon. s.n.*, 27 Aug. 1974 (KEP). MALACCA: sine loco, *Maingay* 1644 (*Kew dist.* 172) (K). PAHANG: Ulu Bertram at Kuala Mensum, 549 m., *FRI* 20070 (K, KEP, SAR); Lesong F.R., near Sungei Jekatih, "low hill," *FRI* 15995 (A, K, KEP); King George Vth Natl. Park, 180 m., *KEP* 71956 (KEP); Kuala Lompat, 45 m., *Chivers DCL* 45 (KEP), 406 (KEP); Gali, Raub, *SFN* 16220 (SING). JOHORE: Kluang, *SFN* 9424 (SING). **Sumatra and adjacent islands.** BARAT: Ond. afd. Oud Agam, Sipisang, 660 m., *bb* 2872 (BO, L). UTARA: Angkola en Sipirok Panobasan, Dk. Poehoetan Lajan, 600 m., *bb* 31537 (A, BO, NY, SING); Sibolga, Laboean Talang, P. Poenei (P. Morsala), 260 m., *bb* 19292 (A, BO, L); Is. Morsala, Bukit Muara Talang, 40 m., *Kostermans' collector* 24 (A, BO, K, L). ATJEH: Simaloer, *Achmad* 391 (?) (BO), 517 (?) (BO, L, U); 601 (?) (BO, L, U); Asahan, Simpang Toba, 10 m., *bb* 8442 (BO). BANGKA: prope Djeboes, *Teysmann, HB* 3222 (?) (BO). BORNEO. KALIMANTAN. TIMUR: Boeloengan, Kabiran, S. Simendoeroet, 200 m., *bb* 11760 (BO). JAVA. BARAT: Passier Toegoe, Kikoehkoeran, *Hasskarl* 392 (L).

ECOLOGY. Usually in colline mixed dipterocarp forest, 10–660 m. alt. Flowering in January; fruiting November (?ripe), January, February, April, and June (fruit green, finely mottled with yellow, or "bronzed" (*FRI* 20070); reported to be eaten by siamang (*Chivers DCL* 406; Chivers, 1974)).

LOCAL USES. In Pahang, Malaya, it is used as a medicine: "Sidauwai puteh [used] after child[birth] with a decoction of the root" (*SFN* 16220). In Bangka the bast is used in atap thatching (as a tie?).

*Calophyllum dioscurii* is a distinctive species that is easily recognized, even when sterile, by its small, prominently acuminate leaf blades that dry pale brownish green and have very dense, fine venation, and by its pale-drying twigs that contrast strongly with the dark-drying petioles. In addition, the internodes tend to be rather short (usually less than 3 cm.); the pedicels are short; and air spaces develop in the outer layer of the fruit. The epithet is taken from Dioscuri, the name given to Castor and Pollux, inseparable twins of classical mythology, in commemoration of the work of M. R. Henderson and J. Wyatt-Smith on the genus.

Henderson and Wyatt-Smith (*loc. cit.*) compared this species with *Calophyllum gracillimum*. However, in that species the venation is obscure, the indumentum is much better developed, and there are hairs on the anthers; in fruit the two are not similar. They also thought that *C. floribundum* (= *C. tetrapterum* var. *tetrapterum*) was close to *C. dioscurii*. However, there are numerous differences in vegetative and fruit characters (venation density, twig color and type, thickness of the outer and woody layers of the fruit), and the two species are not closely related.

The specimens cited above that were collected from Simaloer, Sumatra, differ from the others in having a thicker lamina that is acute to acuminate at the apex, dries more or less brown, and has less dense venation; they also have stouter petioles. The characters in which they differ from the other specimens are enclosed in brackets in the above description. *Hasskarl* 302, from Java, is a sterile specimen, perhaps collected from a young tree; it has a lamina up to 12 by 3.1 cm.

107. *Calophyllum banyengii* P. F. Stevens, sp. nov.

A speciebus aliis *Calophylli* in ramulo tenui 0.8–1.2 mm. in transverso in siccitate flavido, petiolo tenui in siccitate nigrescenti, lamina chartacea mediocra valde acuminata (lamina 4.8–10.5 cm. longa acumine 1–1.5 cm. longo) margine valde undulata, fructu late ovoideo putamine tenuissimo (minus quam 0.1 mm. crasso), differt.

Tree 8–12 meters tall, d.b.h. to 10 cm.; trunk without buttresses; outer bark yellowish, smooth, the inner surface straw brown; under bark reddish; inner bark pale red; latex yellow, (?)clear, sparse, sticky.

Twigs flattened, 0.8–1.2 mm. across, rounded or with 4 raised lines, drying yellowish to pale brown, subpersistently brown-farinose; axillary innovations lacking basal scars (with pair of scars ca. 5 mm. from base); internodes 1–7 cm. long; uppermost pair of axillary buds subacate, to 3 mm. long, erect; terminal bud narrowly conical, 3.5–4(–5.5) mm. long, with  $\pm$  appressed, brown indumentum (hairs, FIGURE 34, h–j; cf. 34, c), underdeveloped internode absent (to 4 mm. long). Petiole 0.7–1.8 cm. long,  $\pm$  deeply concave above and convex below, subglabrous, drying blackish; lamina elliptic-oblong, 4.8–10.5 by 2.2–3.9 cm., acuminate at apex, acumen slender and to 1.5 cm. long, acute at base, strongly and closely undulate and slightly recurved at margin, thinly coriaceous, drying dark olivaceous-buff above and olivaceous below, subpersistently farinose on midrib above, the midrib above gradually narrowed from already narrow base, raised, 0.1–0.15 mm. wide at midpoint, below raised, striate to obscurely angled, the venation subobscure on both surfaces, slightly raised, latex canals impressed below, 8 to 14 veins/5 mm., angle of divergence 70–75°. Inflorescences from foliate axils along twigs, with 3 to 7 flowers, unbranched, the axis (0.1–)0.6–2 cm. long, puberulent, lowest internode (1–)4–7 mm. long; bracts subovate, to 3 mm. long, deciduous (subpersistent); pedicels (2–)5–12 mm. long, sparsely puberulent. Flower known only in bud, (?)hermaphroditic; tepals (?6 or) 8, the outer pair ovate, 1.6–3 by 1.4–2.2 mm.,  $\pm$  puberulent on back, the inner ones persisting at the base of fruit, obovate, ca. 5 by 2.3 mm.; stamens 140 to 175, the filaments to 4.5 mm. long, the anthers oblong, ca. 0.6 mm. long, subretuse at apex. Submature fruit broadly ellipsoid to ovoid, ca. 1.2 by 1 cm., drying pruinose-brown, obscurely striate; outer layer not detaching cleanly from stone, ca. 0.8 mm. thick, compact; stone subspherical, ca. 1 by 0.85 cm., rounded at apex, the walls less than 0.1 mm. thick, smooth, (?)unmarked; spongy layer at first thick.

TYPE: Sarawak, 1st Division, Gunong Santubong, 54 m., 20 Dec. 1975, *Stevens et al.* 296 (holotype, A; isotype, SAR).

DISTRIBUTION. Northern Borneo, scattered (MAP 36).

ADDITIONAL SPECIMENS SEEN: **BORNEO.** SARAWAK. 4th Division: Miri, proposed Lambir Natl. Park, S 25074 (A, L, SAN, SAR, SING). SABAH. Kinabatangan: Brassey Range, 660 m., *Stevens et al.* 578 (?) (A).

ECOLOGY. On Gunong Santubong, in lowland dipterocarp forest, ca. 54 m. alt. Well-developed flower buds and submature fruits in December.

*Calophyllum banyengii* can be recognized by its slender, yellowish-drying twigs; its slender, blackish-drying petioles; and its medium-sized lamina with a strongly acuminate apex and closely undulate margins. Its flowers have about eight tepals, and its ovoid fruits have a rather thin, but compact, outer layer and a very thin-walled stone. The epithet commemorates Banyeng ap Nudong, who found the tree from which the type collection was made beside the much-traveled track up Gunong Santubong.

*Calophyllum banyengii* is at least superficially similar to *C. dioscurii*: the terminal buds of the species are similar, as are the yellowish-drying twigs and the acuminate leaves. However, *C. dioscurii* has smaller, more coriaceous leaf blades that are more shortly and less abruptly acuminate, stouter twigs, and shorter petioles. The fruits are smaller, large air spaces develop in the outer layer, and the stone has a perfectly distinct wall ca. 0.2 mm. thick.

In some flowers of *Calophyllum banyengii* the outermost pair of tepals appears to be markedly smaller than the next pair. These outermost tepals are separated from the others by a short length of pedicel and appear to be bracts that lack axillary flowers.

*Stevens et al.* 478, from the Brassey Range in Sabah, is similar to the specimens from Sarawak except that the lamina is narrower (up to 11.8 by 3.1 cm.) and is gradually acuminate at the apex, and the petiole is at least 6 mm. long. There is a tendency for the veins on the upper surface of the lamina to be impressed. However, the fresh leaf had a notably undulate margin, as did the individual from which the type specimen was taken.

108. *Calophyllum novoguineense* Kanehira & Hatusima, Bot. Mag. Tokyo **56**: 562. fig. 3. 1942; P. F. Stevens, Austral. Jour. Bot. **22**: 409. 1974. TYPE: Dutch New Guinea [Irian Jaya], Boemi, 40 km. inward of Nabire, 300 m., 10 March 1940, *Kanehira & Hatusima* 12701 (isotypes, A, BO).

*C. warenense* Kanehira & Hatusima, Bot. Mag. Tokyo **56**: 564. fig. 5. 1942; P. F. Stevens, Austral. Jour. Bot. **22**: 409. 1974. TYPE: Dutch New Guinea [Irian Jaya], Waren, 96 km. south of Manokwari, 2 m., 23 March 1940, *Kanehira & Hatusima* 13708 (isotypes, A, BO).

Tree 15–20 meters tall, d.b.h. to 20 cm.; outer bark yellow-brown, smooth except for fine vertical cracks, the inner surface dull straw-brown; under bark red to deep red; inner bark red; latex cloudy, not sticky, white or

becoming white when rubbed (details from Papuan specimens).

Twigs slightly flattened, 0.4–1.2 mm. across, 4-angled, drying brown (yellowish when old), with sparse,  $\pm$  adpressed hairs when young; axillary innovations lacking basal scars; internodes (0.2–)0.5–2 cm. long; uppermost pair of axillary buds rounded, 0.7–1.2 mm. long, suberect; terminal bud subconical, 1–2 mm. long, with brown, adpressed to spreading, puberulent indumentum (hairs, FIGURE 34, t, u; cf. 34, l), underdeveloped internode to 1 mm. long. Petiole 1–4 mm. long, broadly concave above, convex below,  $\pm$  glabrescent; lamina elliptic to subcuneiform or subobovate, 0.6–5 by 0.35–3 cm., subacute to rounded at apex, cuneate at base, somewhat undulate and recurved at margin, entire lamina often  $\pm$  boat shaped, coriaceous, drying brown-vinaceous to umber above and umber to sabelline-sepia below, with subadpressed to erect hairs on midrib below (on entire lower surface), the midrib above narrowing gradually from base,  $\pm$  raised, (0.07–)0.15–0.3 mm. wide at midpoint, sometimes disappearing up to 5 mm. below apex, below only slightly raised, striate, the venation above subobscure, below apparent, raised, 5 to 9 (to 11) veins/5 mm., angle of divergence 50–70°. Inflorescences from foliate axils, with 3 to 7 flowers, unbranched, the axis 0.2–2.5 cm. long, pubescent, especially toward base, sometimes glabrous above, lowest internode (2–)4–7 mm. long; bracts elliptic, ca. 1.5 mm. long, caducous; pedicels 3–15 mm. long, glabrous or sparsely pubescent. Flower (?)hermaphroditic; tepals 4, glabrous or almost so, the outer pair suborbicular to ovate-elliptic, 2.5–3.2 by 2–2.5 mm., the inner pair subelliptic, 2–3.5 by 1.5–2.5 mm.; stamens 20 to 35, the filaments to 2 mm. long, the anthers elliptic to oblong, 0.4–1.5 mm. long, retuse at apex; ovary 0.4–1 mm. long, the style ca. 1 mm. long, the stigma peltate, 0.3–0.5 mm. across,  $\pm$  3-radiate. Fruit spherical, 5–7 by 4.5–6 mm., apiculate, drying brown,  $\pm$  wrinkled; outer layer not detaching cleanly from stone, 0.3–0.5 mm. thick, becoming disorganized by air spaces; stone spherical to ellipsoid, 3.5–6.5 by 3–5.5 mm., rounded at apex, the walls less than 0.1 mm. thick, smooth, (?)unmarked; spongy layer thin.

DISTRIBUTION. Western New Guinea (MAP 45).

ADDITIONAL SPECIMENS SEEN. **Papuasias**. IRIAN JAYA. Fakfak: Genofa, 750 m., *bb* 22569 (A, B, BO, L, SING). Djajapura: Cycloop Mts., Ifar, 400 m., *van Royen & Sleumer* 6592 (K, L). PAPUA NEW GUINEA. Western: Kiunga Airstrip, 25 m., *NGF* 18302 (A, CANB, E, K, LAE, M, MO, SING), 20 km. from Kiunga on Rumginae road, 30 m., *Stevens et al.* 919 (A).

ECOLOGY. Varied habitats: *NGF* 18302 at edge of lowland freshwater swamp; *Stevens et al.* 919 in well-drained lowland forest; *Kanehira & Hatusima* 13708 in dry thicket by seashore; *Kanehira & Hatusima* 12701 in colline, *Agathis*-dominated forest; *bb* 22569 on chalk; 2–750 m. alt. Flowering March, April, and August; fruiting April, August (submature), and September.

YOUNG PLANT. Young plants ca. 30 cm. tall have short (less than 1 cm.) internodes and narrowly elliptic leaf blades; the terminal bud is functional, and growth is erect. Innovations from the terminal bud lacked basal scars, while innovations from axillary buds had them. (Observations made on numerous plants beneath the tree from which *Stevens et al.* 919 was collected.)

TABLE 14. Differences between western Papuan species of the *Calophyllum novoguineense* complex.

	<i>C. novoguineense</i>	<i>C. bicolor</i>	<i>C. caudatum</i>	<i>C. undulatum</i>	<i>C. bifurcatum</i>	<i>C. parvifolium</i>
TWIG THICKNESS (mm.)	0.4-1.2	1.5-2.5	0.7-1	Ca. 1	1-1.4	0.7-1.2
TERMINAL BUD						
LENGTH (mm.)	1-2	4-7	2-3	1.5-3	3-5.5	1.8-3
FUNCTIONAL	+	+	+	+	(?)—	+
LAMINA						
LENGTH (cm.)	0.6-5	(2-)4-8(-13)	3.7-5.5	5.3-10.5	(4-)8-15	2.5-4
APEX SHAPE	Subacute- rounded	Acute- acuminate	Acuminate- caudate	Long- acuminate	Long- acuminate	Acute (rounded)
BASE SHAPE	Acute	Rounded- acute	Cuneate	Acute	Rounded	Cordate
MARGIN CLOSELY						
UNDULATE	—	—	—	+	+	—
DRYING STRONGLY						
BICOLORED	—	+	—	—	—	—
HAIRS PERSISTING ON						
LOWER SURFACE	—(+)	+(—)	—	—	—	—
MIDRIB SURROUNDED BY						
RAISED LAMINA	—	—	—	+	—	—
VEINS/5 mm.	5 to 9 (to 11)	4 to 9	11 to 14	(7 to) 9 to 16	6 to 8	4 to 7
FOLIACEOUS BRACTS						
PERSISTENT	—	—	+	+—	—	—
PEDICEL LENGTH (cm.)	0.3-1.5	0.35-1.6	0.4-0.9(-1.2)	0.35-0.9	1.1-1.8	2.2-3.5

*Calophyllum novoguineense* can be characterized by its strongly four-angled twigs, its small terminal bud, and its lamina less than 5 cm. long that is at most subacute at the apex and that dries notably darker brown above than below. The flowers have four tepals and few anthers; the fruits are small. The type specimen was collected from New Guinea; hence the epithet.

*Calophyllum novoguineense* is a member of a complex of largely allopatric taxa occurring from the Moluccas to Fiji. All members have similar hairs, characterized by having at most a single rounded, basal branch and a notably rough surface (see FIGURES 34, k-u; 35, a); the leaves and fruits are generally small (the latter are larger in *C. confusum*). The flowers, where known, have few stamens and usually only four tepals. Species limits in the taxa centered on New Guinea (*C. novoguineense*, *C. bicolor*, *C. parvifolium*, and *C. caudatum*) are not very clear, but characters by which they can be distinguished are listed in TABLE 14.

*Calophyllum novoguineense* is closest to *C. bicolor*, which also frequently has hairs on the lower surface of the lamina; in both species, walls of the spongy mesophyll are lignified (for *C. bicolor*, see Stevens, 1974 (as *C. caudatum*); for *C. novoguineense*, specimens cited). *Calophyllum novoguineense* is superficially similar to *C. pisiferum*, but that species has much more robust twigs, larger leaf blades and inflorescences, very different hairs, and flowers with smaller anthers.

The type specimen of *Calophyllum warensense* and *van Royen & Sleumer* 6592 both have longer inflorescence axes and anthers about three times as long as those of other specimens; however, pollen from the anthers of the type specimens of *C. warensense* and *C. novoguineense* was of similar size and became colored in cotton blue, so was presumably fertile. All the specimens cited have fairly similar leaves and twigs, although there is some variation in the size, shape, and texture of the lamina: the leaf blades of *van Royen & Sleumer* 6592 are somewhat larger and more coriaceous than those of the others, and they dry almost flat; those of *Stevens et al.* 919 are smaller but otherwise rather similar.

There is no difference in venation density between *Kanehira & Hatusima* 12701 and 13708, although Kanehira and Hatusima (*loc. cit.*) thought that there was. The indumentum of the type specimens of *Calophyllum warensense* and *C. novoguineense* is suberect (that of the other specimens is subadpressed), and apart from inflorescence size, the two can hardly be differentiated. Therefore, I have no hesitation in reducing the name *C. warensense* to synonymy.

109. *Calophyllum bicolor* P. F. Stevens, sp. nov.

FIGURE 33, a, f.

*C. caudatum* auct., non Kanehira & Hatusima; P. F. Stevens, Austral. Jour. Bot. 22: 362. 1974.

A speciebus aliis Calophylli in indumento tomentoso persistenti in ramulis, pagina inferiore laminae, axi inflorescentiae et pedicellis praedito, lamina ovata parva vel mediocra in siccitate bicolori margine leviter undulata haud vel leviter recurvata, et fructu strato exteriori circa 0.2 mm. crasso lacunis evolutentibus, differt.

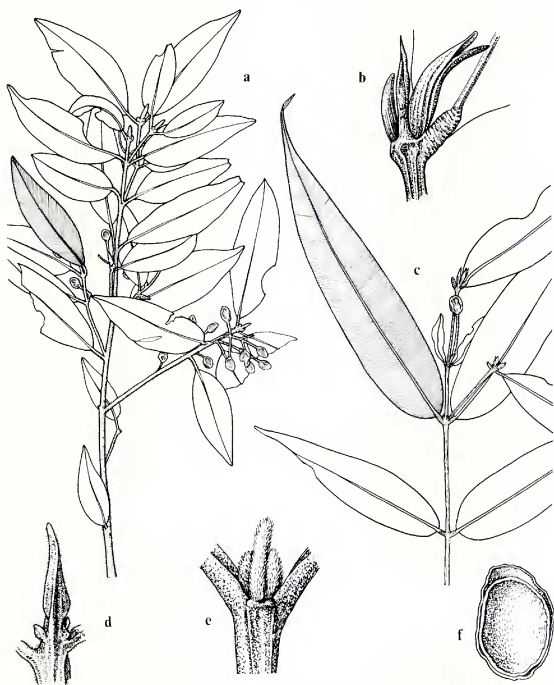


FIGURE 33. a, f, *Calophyllum bicolor* (Pullen 7484): a, habit,  $\times 0.5$ ; f, fruit, transverse section,  $\times 3$ . b, c, *C. bifurcatum* (Aet & Idjan 410): b, terminal bud,  $\times 3$ ; c, habit,  $\times 0.5$ . d, *C. archipelagi* (Kostermans & Wirawan 921), terminal bud,  $\times 3$ . e, *C. undulatum* (Kuswata & Soepadmo 261), terminal bud,  $\times 6$ .

Tree 17–30 meters tall, d.b.h. to 48 cm.; trunk without buttresses; outer bark yellowish to yellowish gray, or gray and brown mottled, smooth when young, becoming fissured and scaly, the inner surface dark straw to straw; under bark brownish red; inner bark pale red to pink; latex yellow, brown, perhaps colorless, clear (rarely milky), sticky.

Twigs slightly flattened, 1.5–2.5 mm. across, slightly 4-angled to rounded, drying brown to dark brown, yellowish brown when older, often persistently brown-tomentose to pubescent; axillary innovations lacking basal scars; internodes 1–2(–4) cm. long; uppermost pair of axillary buds rounded, 0.5–1.5 mm. long, suberect; terminal bud plump, 4–7 mm. long, with brown-tomentose indumentum (hairs, FIGURE 34, k, l), underdeveloped internode to 2.5 mm. long. Petiole 2–7 mm. long,  $\pm$  concave above and convex below, subsersistently tomentose; lamina ovate to elliptic, (2–)4–8(–13) by (1–)1.5–3(–4) cm., acute to acuminate at apex, rounded or truncate to cuneate at base, slightly undulate and not recurved or slightly so at margin, coriaceous, drying hazel, vinaceous-brown, or olivaceous to sabelline above and honey to near sabelline below, pubescent-tomentose on midrib on both surfaces and sparsely over entire lower surface, the midrib above generally gradually narrowed from base, raised (flat at base), 0.2–0.4 mm. wide at midpoint, below raised, striate, the venation  $\pm$  obscure above and apparent below, raised, 4 to 9 veins/5 mm., angle of divergence 50–65°. Inflorescences from foliate (rarely defoliate) axils along twigs, with 3 to 5 flowers, unbranched, the axis 0.3–1.6 cm. long, pubescent-tomentose, lowest internode 3–5(–10) mm. long; bracts not known; pedicels 0.35–1.6 cm. long, pubescent to subtomentose. Flower (?)hermaphroditic; tepals 4, subelliptic, to 4 by 2.8 mm.; stamens ca. 40, the filaments to 2.5 mm. long, the anthers 0.7–1 mm. long, rounded at apex; ovary 1.2–1.5 mm. long, the style ca. 2 mm. long, the stigma peltate, ca. 1.1 mm. across, 3-radiate. Fruit ovoid to ellipsoid, 7–11 by 5–9 mm., apiculate, drying brown,  $\pm$  smooth to slightly wrinkled; outer layer not detaching cleanly from stone, ca. 0.2 mm. thick, with large air spaces developing; stone ovoid-ellipsoid, 6–9 by 4.5–7.5 mm., rounded at apex, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Papua New Guinea, Western District, Oriomo Creek, mouth of Yakup Creek, 40 miles [64 km.] from the sea, 45 feet [13.5 m.], 23 Sept. 1963, NGF 17746 coll. Womersley (holotype, A; isotypes, CANB, E, K, L, LAE, NSW).

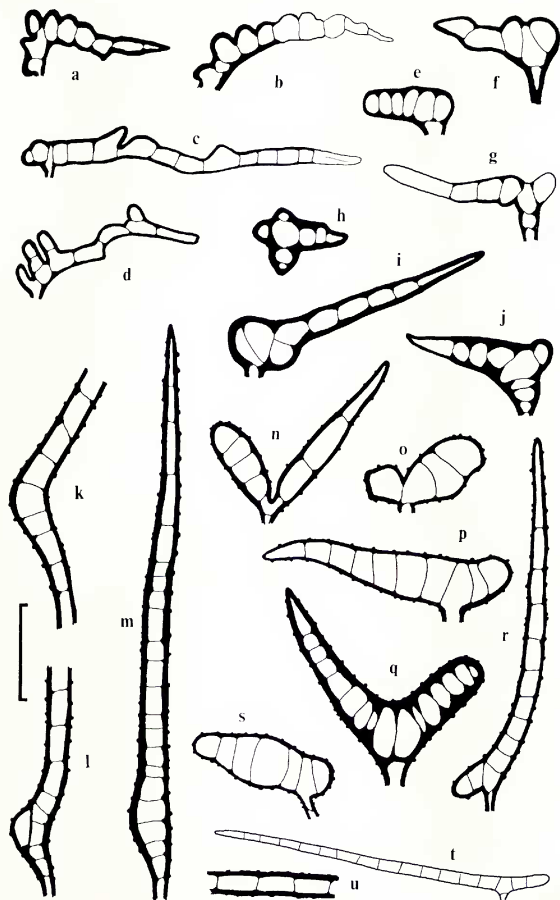
DISTRIBUTION. Western New Guinea, the Aru Islands, and Australia (Queensland) (MAP 37).

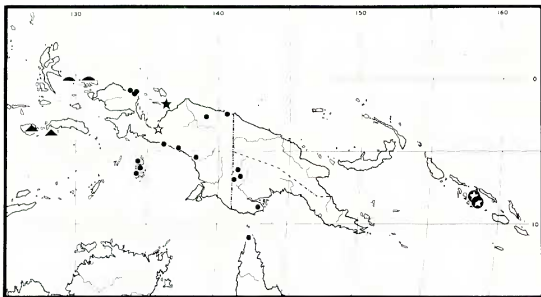
ADDITIONAL SPECIMENS SEEN. **Papuasias.** IRIAN JAYA. Aru: P. Kobroor, Dosinamala, 20 m., *bb* 25283 (K, L, NY, SING); P. Trangan, 30 m., *bb* 25463 (L, NY, SING), *Buwalda* 5425 (K, L); [P. Wokam] Giabu-leŋgan, *Beccari*, *PP*

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FIGURE 34. Hairs (from terminal bud, unless otherwise noted). a, b, *Calophyllum incumbens* (Kostermans 13037). c–g, *C. dioscurii*: c, d, *FRI* 11719; e, *Achmad* 601; f, g, *bb* 2872. h–j, *C. banyengii* (Stevens et al. 296): h, from above; i, from lateral bud. k, l, *C. bicolor*: k, *Pullen* 7484, base of hair ca. 590  $\mu$ m. long; l, *NGF* 17746, base of hair ca. 480  $\mu$ m. long. m, q, *C. leucocarpum* (A. C. Smith 6820). n, *C. confusum* (BSIP 424). o, p, s, *C. bifurcatum* (Aet & Idjan 410). r, *C. caudatum* (Kanehira & Hatusima 12030). t, u, *C. novoguineense* (NGF 18302): u, part of hair. Scale = 60  $\mu$ m. (in t, scale = 120  $\mu$ m.).







MAP 37. Distribution of *Calophyllum undulatum* (triangles), *C. parvifolium* (half-circles), *C. bicolor* (circles), *C. caudatum* (open star), *C. bifurcatum* (solid star), and *C. confusum* (stars in solid circles) in Papuaia.

1137-1137C (FI). Vogelkop: Manokwari, *BW* 1786 (CANB, L); Sidai ( $\pm$  50 km. W. of Manokwari), 5-20 m., *BW* 6761 (A, BO, CANB, L, LAE), *BW* 6763 (CANB, L, LAE), 10 m., *BW* 6929 (L); Beri Creek, near Andai, SW. of Manokwari, 80 m., *BW* 11953 (L, LAE). Djajapura: distr. Jafi, Singgi, 250 m., *BW* 2855 (CANB, L); Hollandia ("Noordwijk"), 5 m., *BW* 2888 (CANB, L, LAE); Bodem R., 60 km. SE. from Sarmi, 75 m., *BW* 5878 (CANB, L, LAE). Mimika: Najaja (Oeta), *bb* 32849 (*Exp. Lundquist* 130) (BO, L), 3 m., *Aët* (*Exp. Lundquist*) 340 (BO, L); Moejoe, ca. 55 km. N. from Mindiptana, 100 m., *BW* 6482 (CANB, L, LAE); Otakwa, 0 m., *bb* 22087 (BO); Lorentz R., *bb* 22109 (BO). PAPUA NEW GUINEA. Western: Kiunga, 25 m., *NGF* 18367 (A, CANB, E, L, LAE, M, MO, SING), 24 m., *LAE* 51789 (A, CANB, E, K, LAE), *Stevens et al.* 889 (A), 915 (A); Kaim R., Lake Murray area, 15 m., *Pullen* 7484 (A, CANB, K, L, LAE); near Boset Lagoon, Middle Fly R., 30 m., *Pullen* 7385 (A, CANB, K, L, LAE). AUSTRALIA. QUEENSLAND: Cape York Peninsula, Bamaga, *Webb & Tracey* 8027 (NSW).

ECOLOGY. Seasonally inundated or well-drained rainforest, 3-100(-250) m. alt. In southern Western Province, in *Melaleuca* forest, or forest with *Melaleuca* and *Acacia*; sometimes in secondary forest. Flowering March, June, and August; fruiting February, May, June, September, and October (ripe fruit deep blue to black).

*Calophyllum bicolor* is a distinctive species recognizable by the puberulotomentose indumentum that persists on the twigs, lower surface of the lamina, inflorescence axis, and pedicels, and by its small to medium-sized, ovate or sometimes elliptic lamina that commonly dries hazel-brown-vinaceous-olivaceous on the upper surface and honey-sabelline on the lower. The flowers have four tepals that are glabrous on the back, and the fruit has a thin

outer layer and a thin-walled stone. The epithet *bicolor* ("two colors") was chosen because of the different colors of the upper and lower surfaces of the dried leaf.

*Calophyllum bicolor* can readily be distinguished from *C. caudatum*, with which I had earlier confused it; for the differences between them, see TABLE 14. *Calophyllum bicolor* is perhaps most similar to *C. novoguineense*. Both species apparently grow in the Kiunga area, and careful studies are needed to see if they can be distinguished on bark and/or seedling and young plant differences.

110. ***Calophyllum caudatum*** Kanehira & Hatusima, Bot. Mag. Tokyo **56**: 561. fig. 2. 1942. TYPE: Dutch New Guinea [Irian Jaya], Dalman, 40 km. in from Nabire, 400 m., 1 May 1940, Kanehira & Hatusima 12030 (isotypes, A, BO).

Tree ca. 5 meters tall; trunk and bark not known.

Twigs slightly flattened, 0.7–1 mm. across, obscurely 4-angled at first, soon becoming rounded, drying brown, sparsely pubescent when young, glabrescent; axillary innovations lacking basal scars; internodes 0.7–1.7 cm. long; uppermost pair of axillary buds rounded, ca. 0.7 mm. long, spreading; terminal bud plump, 2–3 mm. long, with subspreading, red-brown indumentum (hairs, FIGURE 34, r), underdeveloped internode absent. Petiole 3–4 mm. long, deeply concave above, convex below, pubescent; lamina narrowly ovate, 3.7–5.5 by 1–1.7 cm., acuminate to caudate at apex, cuneate at base, slightly undulate but not recurved at margin, fairly thin, coriaceous, drying sabelline or olivaceous above and umber below, sparsely pubescent when young, some hairs persisting on midrib below, the midrib above narrowing gradually from base, raised, ca. 0.2 mm. wide at midpoint, below not very prominent, slightly raised, striate, the venation obscure above, obscure to subapparent below, slightly raised below, 11 to 14 veins/5 mm., angle of divergence 55–70°. Inflorescences from foliate axils, with ca. 3 flowers, unbranched, the axis 4–9 mm. long, slender, sparsely pubescent, lowest internode 4–9 mm. long; bracts narrowly ovate, ca. 5 mm. long, persisting almost to anthesis; pedicels 0.4–0.9(–1.2) cm. long,  $\pm$  glabrous, slender. Flower known only in late bud, (?)hermaphroditic; tepals 4 or 6, glabrous, the outer pair suborbicular, ca. 2.2 mm. long; stamens 25 to 35, the filaments ca. 1 mm. long, the anthers oblong, ca. 1 mm. long, rounded to retuse at apex; ovary ca. 0.8 mm. long, style ca. 1 mm. long, stigma peltate. Fruit unknown.

DISTRIBUTION. Irian Jaya (MAP 37); known only from one collection.

ECOLOGY. Edge of *Agathis* forest, 400 m. alt. Late bud in early May.

*Calophyllum caudatum* can be recognized by its slender twigs, its narrowly ovate lamina 3.7–5.5 by 1–1.7 cm. with the apex acuminate to caudate and the midrib and venation both inconspicuous, and its slender, three-flowered inflorescence. The epithet is appropriate because the leaf blade is caudate at the apex.

*Calophyllum caudatum* appears to be related to the other small-leaved species of the genus occurring in the western part of New Guinea. The differences separating it from *C. bicolor*, with which it has been confused, are dealt with under the latter species. It differs from *C. insularum*, which has similarly shaped leaves, in having somewhat less dense and much less obvious venation; much smaller flowers with fewer, glabrous tepals and fewer, smaller anthers; and different hair structure (cf. FIGURES 34, r, and 46, a-d); the two species are not at all close.

From the figure accompanying the description of *Calophyllum caudatum*, it would appear that the bracts can be up to 1.5 cm. in length, although they were described as "bracteolis lanceolatis circ. 3 mm. longis."

111. *Calophyllum undulatum* P. F. Stevens, sp. nov.

FIGURE 33, e.

*Calophyllum* sp. Merr. Interp. Rumph. Herb. Amboin. 371. 1917.

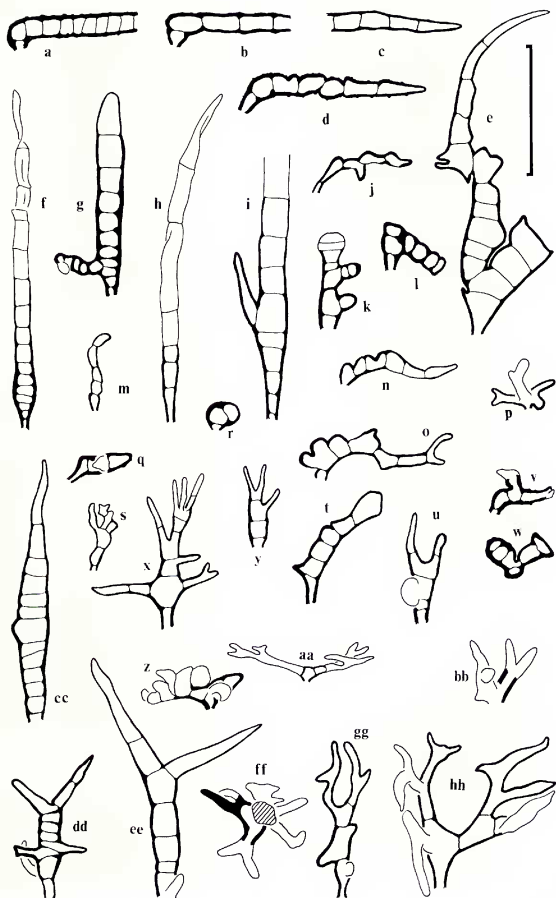
A speciebus aliis Calophylli in innovationibus axillaribus cicatricibus basali-bus haud ornatis, lamina (anguste) ovata margine anguste valdeque undulata costa supra elevata pagina laminae circumcinctae elevata et costa infra marginibus depressis, differt.

Tree 20-27 meters tall, d.b.h. to 33 cm.; outer bark grayish brown, thin, with slender cracks; inner bark red-brown.

Twigs slightly flattened, ca. 1 mm. across, 4-angled, drying brown, glabrous or with sparse, adpressed indumentum; axillary innovations lacking basal scars; internodes 0.7-5(-7) cm. long; uppermost pair of axillary buds  $\pm$  rounded, 0.5-1.3 mm. long, suberect; terminal bud conical, 1.5-3 mm. long, with adpressed, brown indumentum (hairs, FIGURE 35, a; cf. 34, p), underdeveloped internode absent. Petiole 3.5-7 mm. long, deeply concave above and convex below, soon glabrescent; lamina ovate to narrowly ovate, 5.3-10.5 by 1.8-3.6 cm., long-acuminate at apex, acute at base, strongly and closely undulate and at most slightly recurved at margin, coriaceous, drying shiny, umber to ferruginous above and umber below, glabrous or with sparse,

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FIGURE 35. Hairs (from terminal bud, unless otherwise noted). a, *Calophyllum undulatum* (Pl. Rumph. Amboin. 483), base of hair ca. 250  $\mu$ m. long. b-d, *C. articulatum* (Kuswata & Soepadmo 219): b, c, base and apex of hair ca. 420  $\mu$ m. long; d, from axillary bud. e, *C. savannarum* (bb 30477), axillary bud. f, g, *C. vitiense* var. *amblyphyllum* (A. C. Smith 9243). h-j, m-o, *C. neo-ebudicum*: h, n, BSIP 429; i, Kajewski 2463, base of hair ca. 840  $\mu$ m. long; j, m, NGF 2873; o, A. C. Smith 6449. k, l, *C. vitiense* var. *vitiense*: k, Gillespie 2407; l, A. C. Smith 7201. p, *Calophyllum* sp. 121, *Decades Philip. Forest Fl.* 142. q-s, z, *C. cerasiferum*: q, A. C. Smith 8286; r, A. C. Smith 8553; s, A. C. Smith 8525; z, A. C. Smith 1789. t-w, *C. caledonicum*: t, Baumann-Bodenheim 16088; u, Viro 522; v, w, Viro 1340, from above. x, y, cc-ee, *C. collinum*: x, Brass & Versteegh 13576; y, dd; Stevens et al. 890; cc, ee, NGF 45057. aa, bb, ff, *C. carrii* var. *carrii*: aa, ff, Carr 15599, from peduncle; ff, from below; bb, LAE 60276, from stem. gg, hh, *C. costatum* (Hyland 8912), from stem. Scale = 120  $\mu$ m.



subadpressed indumentum  $\pm$  persisting on midrib below, the midrib above gradually narrowed from base, raised, surrounding lamina also raised, 0.15–0.25 mm. wide at midpoint, below slightly raised, margins depressed, striate, the venation subapparent, slightly raised, latex canals below impressed, (7 to) 9 to 16 veins/5 mm., angle of divergence 65–80°. Inflorescences from foliate axils, with (1 to) 3 to 5 flowers, unbranched, the axis (0.5–)0.6–1.5 cm. long, with adpressed indumentum toward base, lowest internode 3–8 mm. long; bracts at least sometimes foliaceous, to 2.7 by 1 cm., subpersistent; pedicels 3.5–9 mm. long, glabrous. Flower (?)hermaphroditic; tepals 4, glabrous, the outer pair elliptic, ca. 4 by 3 mm., the inner pair subobovate, ca. 4.5 by 3 mm.; stamens ca. 40, the filaments to 2.5 mm. long, the anthers oblong, 1–1.2 mm. long, subrounded at apex; ovary ca. 0.8 mm. long, the style ca. 1.5 mm. long, the stigma subpeltate, ca. 0.3 mm. across. Fruit subspherical, 6–9 by 5–9 mm., rounded at apex, drying brown, shallowly wrinkled; outer layer not detaching cleanly from stone, 0.3–0.5 mm. thick, with large air spaces developing; stone ellipsoid, 5.4–8 by 4–6.7 mm., rounded at apex, the walls 0.1–0.2 mm. thick, smooth, (?)unmarked; spongy layer (?)thin.

TYPE: Ambon, Waai, slope of Mt. Salahatu, 200–300 m., 9 July 1959, *Kuswata & Soepadmo 261* (holotype, A; isotypes, BISH, BO (several), C, G, K, KEP, L, LAE, NSW, NY, P, SAN, SING).

DISTRIBUTION. The Moluccas (Ambon and Buru) (MAP 37).

ADDITIONAL SPECIMENS SEEN. **Moluccas.** BURU: Wai Geren Olon, 800 m., *bb 21507* (BO, L). AMBON: Hoetomoeri Road, 300 m., *Pl. Rumph. Amboin. 483* (BO, K, L, P, US); Mt. Toena, *Teysmann s.n.* (BO), *Boerlage 301* (BO); Haeosaroeroe, 400 m., *bb 14292* (BO), *Salahoetoe, Rant 661* (sapling) (BO), *Boerlage 173* (BO); Alang, *Boerlage 419* (BO); sine loco, *Hombroen s.n.*, anno 1841 (P), *anon. 14614* (BO). Sine loco: *anon.*, MEL 62322 (MEL).

ECOLOGY. Colline forest, 200–800 m. alt. Fruiting in July (ripe fruit reported to be black).

*Calophyllum undulatum* is a very distinctive species with rather narrow leaf blades that dry shiny and have strongly and closely undulate margins. The midrib on the upper surface of the lamina is raised but is continuous with the immediate leaf surface (also raised), and the midrib on the lower surface has at least its edges notably impressed. The strongly undulate leaf margins suggested the specific epithet *undulatum*.

In venation density and general leaf shape, *Calophyllum undulatum* is like the poorly known *C. caudatum* (from Irian Jaya); the two species can be distinguished by the characters given in TABLE 14. The specimens of *C. undulatum* have adpressed hairs with thickened cell walls; at the base the hairs are asymmetrical. The hairs of *C. caudatum* are subspreading, they are only slightly asymmetrical at the base, and the cell walls are thin, with cuticular striations that are so prominent that the cell walls are partly obscured. However, there is almost comparable variation within *C. novoguineense*, which is also part of the same species complex.

*Calophyllum undulatum* is probably to be equated with the "bintangor montana tertia" of Rumphius (Herb. Amboin. 2: 217. 1741). Merrill (*loc. cit.*), in his interpretation of Rumphius's work, thought that Robinson's collection (*Pl. Rumph. Amboin. 483*) represented an undescribed species, but he was not sure because the collection lacked flowers. Rumphius described the bark as yellowish (compare the description above).

112. *Calophyllum bifurcatum* P. F. Stevens, sp. nov.

A speciebus aliis Calophylli in gemma terminali probabiliter haud fungenti, folia petiolo brevi et lamina basi rotundata apice longa sensimque acuminata, innovationibus axillaribus cicatricibus basalibus ornatis sed inflorescentiis axibus internodiis infimis bene evolutis, differt.

(?)Tree; trunk and bark unknown.

Twigs slightly flattened, 1–1.4 mm. across, 4-angled, soon becoming terete, drying brown, puberulent when young; axillary innovations with basal scars; internodes 2–4 cm. long; uppermost pair of axillary buds plump, acute at apex, 1–4(–7.5) mm. long, spreading, conspicuous; terminal bud plump, 3–5.5 mm. long, with gray-brown, scurfy indumentum (hairs; FIGURE 34, o, p, s), underdeveloped internode absent. Petiole 3–5 mm. long, narrowly concave above and convex below, soon glabrescent; lamina narrowly ovate, (4–)8–15 by (0.7–)1.9–3 cm., gradually acuminate at apex, rounded to shortly truncate at base, closely undulate and slightly recurved at margin, thinly coriaceous, drying cinnamon above and cinnamon to brick below, almost glabrous even when young, the midrib above narrowing gradually from base, raised, 0.2–0.3 mm. wide at midpoint, below raised, obscurely angled, rather narrow, the venation subobscure on both surfaces, slightly less so below, raised, 6 to 8 veins/5 mm., angle of divergence 70–80°. Infructescences from foliate axils, with scars of 3 flowers, unbranched, the axis 3–8 mm. long, sparsely puberulent toward base, lowest internode 3–8 mm. long; bracts not known; pedicels 1.1–1.8 cm. long, glabrous. Flower unknown. Immature fruit subspherical, ca. 8 by 7 mm., apiculate, drying brown, wrinkled; outer layer not detaching cleanly from stone, ca. 0.25 mm. thick, compact; stone (?)spherical, the walls ca. 0.15 mm. thick, smooth; spongy layer (?)thin.

TYPE: Nederlands Nieuwe-Guinea [Irian Jaya], Wasabari near Seroei, Jappen-Biak, 12 Aug. 1939, *Aët & Idjan (exp. L. J. van Dijk)* 410 (holotype, L).

DISTRIBUTION. Japen Island, Irian Jaya (MAP 37); collected only once.

*Calophyllum bifurcatum* can be recognized easily. It has a nonfunctional terminal bud and consequent profuse branching, scars at the bases of the axillary innovations, short petioles, and rather narrowly ovate leaf blades that are long-acuminate at the apex and rounded at the base. The venation is somewhat distant, and the inflorescences are axillary and have a well-developed basal internode. The often subequal branches associated with the abortion of the apex suggest the specific epithet.

*Calophyllum bifurcatum* is perhaps related to *C. caudatum*, but it differs in the characters listed in TABLE 14.

113. *Calophyllum parvifolium* Choisy, Mém. Soc. Phys. Hist. Nat. Paris **1**: 229. 1823; Gaudich. Uranie Phys. Bot. 56. 1826; G. Don, Gen. Syst. **1**: 622. 1831; Choisy, Descr. Guttif. Inde, 44. 1849, Mém. Soc. Phys. Hist. Nat. Genève **12**: 424. 1851; P. F. Stevens, Austral. Jour. Bot. **22**: 383. 1974; *C. microphyllum* Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 282. 1862, *nomen superfluum*; Vesque, Epharmosis **2**: *tt.* 12, 13. 1889, in C. DC. Monogr. Phanerog. **8**: 560. 1893; Lauterb. Bot. Jahrb. **58**: 12. 1922. TYPE: [Waigeo Island] Rawak, *Gaudichaud s.n.* (holotype, P; isotypes, FI, G (as 34)).

*C. microphyllum* Scheffer, Natuurk. Tijds. Nederl.-Indië **32**: 406. 1873, non Planchon & Triana (1862) nec T. Anderson in Hooker f. (1874); *C. schefferi* Vesque in C. DC. Monogr. Phanerog. **8**: 609. 1893, *nomen novum*. TYPE: P. Gebeh, *Teysmann, HB 7868* (holotype, BO; (?)isotype, (anon.) MEL).

(?)Tree or (?)shrub; trunk and bark unknown.

Twigs somewhat flattened, 0.7–1.2 mm. across, obscurely 4-angled, drying brown, glabrous or with subadpressed hairs when young; axillary innovations lacking basal scars; internodes 0.5–2.75 mm. long; uppermost pair of axillary buds rounded, 0.4–1 mm. long, spreading; terminal bud plump, 1.8–3 mm. long, with short, brown, subadpressed indumentum (hairs, cf. FIGURE 34, r), underdeveloped internode to 1.5 mm. long. Petiole 1.5–2 mm. long, concave above, convex below, sparsely puberulent at first; lamina ovate to broadly ovate, 2.5–4 by 1.5–3 cm., acute (rounded) at apex, cordate at base, slightly undulate and not recurved at margin, coriaceous, drying concave, umber to hazel-olivaceous above and umber to sepia below, with subsistent, short hairs on midrib below, the midrib above narrowed gradually from base, level, ca. 0.15 mm. wide at midpoint, below slightly raised, edges  $\pm$  impressed, inconspicuous, the venation obscure to subapparent above and below, raised, 4 to 7 veins/5 mm., angle of divergence 40–60°. Inflorescences from foliate axils, with 3 to 7 flowers, unbranched, the axis 1.5–4.7 cm. long, slender, sparsely puberulent toward base, lowest internode 1–2.5 cm. long; bracts unknown; pedicels 2.2–3.5 cm. long, glabrous, slender. Flower (?)hermaphroditic; tepals reported to be 8, probably 4 in flower examined, the outer ones ovate, ca. 4.5 by 3 mm., the inner ones obovate, ca. 5.5 by 3.5 mm.; stamens ca. 28, the filaments to 2.2 mm. long, the anthers oblong, 1.1–1.4 mm. long,  $\pm$  rounded at apex; ovary ca. 0.8 mm. long, style ca. 1.3 mm. long, stigma not known. Fruit (not seen) reported to be globose, barely 4 mm. long, apiculate.

DISTRIBUTION. Gebeh Island (Moluccas) and nearby Waigeo Island (MAP 37); known only from the two type specimens.

ECOLOGY. Montane forest (Gaudichaud, *loc. cit.*).

*Calophyllum parvifolium* is a poorly known species, characterized by its leaves with small, cordate-based blades and distant venation, and by its long, very slender, glabrous pedicels. The small leaves suggested the specific epithet.



The nomenclature of *Calophyllum parvifolium* and its synonym, *C. microphyllum* Scheffer, was discussed earlier (Stevens, *loc. cit.*). The sheet of *C. parvifolium* at Melbourne (MEL 62310) was probably collected by Teysmann (cf. Stevens, *loc. cit.*) and may be an isotype of *C. microphyllum*. However, neither the holotype nor the presumed isotype of *C. microphyllum* has fruits, although fruits were described in the protolog. In vegetative characters the type specimens of *C. parvifolium* and *C. microphyllum* are similar, and both have long, very slender pedicels.

*Calophyllum parvifolium* is probably most closely related to *C. novoguineense*, which occurs in the western half of New Guinea. *Calophyllum novoguineense* has well-developed, subpersistent indumentum on its twigs, a lamina that is at most rounded at the base, and pedicels up to 15 mm. long (see also TABLE 14). The two species dry in much the same way and apparently have similar flowers, although *C. parvifolium* may have flowers with eight tepals (see description; this would be another difference between the two species).

114. *Calophyllum confusum* P. F. Stevens, Austral. Jour. Bot. **22**: 363, fig. 3. 1974. TYPE: Solomon Islands, northwest New Georgia, Vaimbu River, 100 feet [30 m.], 25 March 1964, BSIP 3154 coll. Whitmore's collectors (holotype, LAE; isotypes, L, SING).

*Calophyllum* sp. T. C. Whitmore, Guide Forest Brit. Solomon Is. 78. 1966.

Tree 9–27 meters tall, d.b.h. to 25 cm.; outer bark greenish yellow to dark brown, becoming scaly; latex white or yellow, sticky.

Twigs flattened, 1–1.5 mm. across, 4-angled, drying blackish, sparsely brown- or grayish-brown-puberulent; axillary innovations lacking basal scars; internodes 1–4.5(–6) cm. long; uppermost pair of axillary buds pointed, to 2.8 mm. long, erect; terminal bud  $\pm$  conical, 3–6.5 mm. long, with brown, subadpressed indumentum (hairs, FIGURE 34, n; cf. 35, a), underdeveloped internode absent. Petiole 0.6–1.1 cm. long, concave above, convex below, slender, drying blackish, glabrous; lamina ovate to elliptic, (3.5–)4.5–8.5 by 1.2–2.6 cm., acute to subacuminate at apex, acute at base, distantly and shallowly undulate but not recurved at margin, thinly coriaceous, drying olivaceous above and sepia below, soon glabrescent or subpersistently puberulent on midrib below, the midrib above gradually narrowed from base,  $\pm$  flat at first, becoming slightly raised, 0.1–0.15 mm. wide at midpoint, below slightly raised, substrate, the venation above subobscure, below subobscure to apparent, raised, latex canals clearly depressed below, 8 to 12 veins/5 mm., angle of divergence 65–75°. Infructescences from upper foliate axils, with scars of 3 (to 5) flowers, (?)unbranched, the axis 0.2–1.5 cm. long, sparsely and subpersistently puberulent toward base, lowest internode 2–15 mm. long; bracts unknown; pedicels 7–11 mm. long, glabrous. Flower unknown. Fruit ovoid, 2.3–2.8 by 1.9–2.2 cm.,  $\pm$  rounded at apex, drying pruinose, smooth; outer layer not detaching cleanly from stone, 2.6–4 mm. thick, compact; stone subellipsoid, 1.7–2 by 1.3–1.6 cm., rounded at apex, the walls 0.2–0.3 mm. thick, smooth, (?)unmarked; spongy layer thin.

DISTRIBUTION. The Solomon Islands, known only from the New Georgia group (MAP 37).

SPECIMENS SEEN. **Papuasias.** SOLOMON ISLANDS: see Stevens, *loc. cit.*

ECOLOGY. Well-drained, primary rain forest, 80 to at least 305 m. alt. Fruiting in March.

*Calophyllum confusum* can be recognized by its slender, profusely branched twigs that dry blackish, its uppermost axillary buds that are tightly appressed to the terminal bud, its rather narrowly ovate to elliptic lamina that dries dark olivaceous on the upper surface, and its relatively large (2.3–2.8 cm. long) fruit that dries smooth and has a thick, compact, outer layer and a thin-walled stone lacking a basal plug. The epithet *confusum* was coined because specimens placed in this species had previously been placed in several quite different ones.

The relationships of *Calophyllum confusum* are not clear; it may be related to *C. leucocarpum*, from the Fiji Islands, and to other species of the *C. novoguineense* complex, although all the other species in the group have much smaller fruits (less than 1.7 cm. long with an outer layer less than 1 mm. thick).

115. *Calophyllum leucocarpum* A. C. Smith, Jour. Arnold Arb. **31**: 314. 1950; A. C. Smith & Darwin, Jour. Arnold Arb. **55**: 219. *figs. 1–3*. 1974. TYPE: Fiji, Vanua Levu, Mathuata, Seanggangga Plateau, in drainage of Korovuli River, vicinity of Natua, 100–299 m., 4 Dec. 1947, A. C. Smith 6820 (holotype, A; isotypes, K, NY, P, US).

*C. neo-ebudicum* auct., non Guillaumin; Parham, Pl. Fiji Is. ed. 2. 192. 1972, *pro parte*.

Slender tree 4 meters tall; trunk and bark unknown.

Twigs slightly flattened, 1–1.5 mm. across,  $\pm$  4-angled, drying mid-brown, sparsely subpersistently tomentose; axillary innovations lacking basal scars; internodes 1–4 cm. long; uppermost pair of axillary buds pointed, 1.5–2 mm. long,  $\pm$  erect; terminal bud conical to somewhat plump, 4.5–5 mm. long, with brown, tomentose indumentum (hairs, FIGURE 34, m, q), underdeveloped internode not apparent. Petiole 0.65–1.2 cm. long, deeply concave above, convex below,  $\pm$  persistently puberulo-tomentose; lamina oblong to elliptic or subovate, 2.7–6.5 by 1–2.6 cm., acuminate at apex, acute to attenuate at base, slightly undulate and recurved at margin, thinly coriaceous, drying umber above and below, subpersistently puberulo-tomentose on midrib above and especially below, the midrib above narrowing gradually from base, strongly raised, 0.13–2 mm. wide at midpoint, below raised, 3-striate, in young leaves edges subdepressed, the venation subobscure on both surfaces, above impressed, below slightly raised, latex canals impressed, 6 to 10 veins/5 mm., angle of divergence 65–75°. Inflorescences axillary, rarely two per axil, with 3 to 5 flowers, unbranched, the axis in flower 0.1–(?)1 cm. long, short-tomentose on lowest internode, otherwise glabrous, lowest internode 1–(?)6 mm. long,

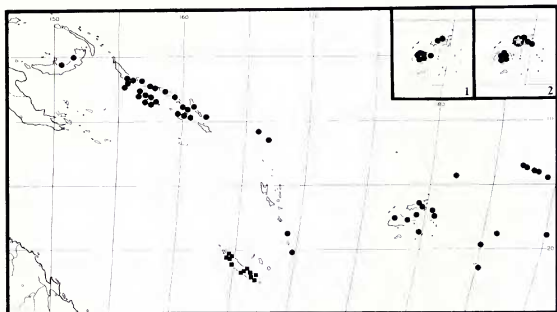
in fruit axis to 1.8 cm. long, lowest internode to 10 mm. long; bracts not known; pedicels 1–3 mm. long, glabrous, in fruit 2.5–6 mm. long. Flower (?)hermaphroditic; tepals 4, the outer pair broadly ovate-elliptic, ca. 3 by 2.6 mm., the inner ones broadly obovate, ca. 4.5 by 4.8 mm.; stamens (?)40 to 70, the filaments ca. 3 mm. long, the anthers suboblong, 0.6–0.9 mm. long, retuse at apex; ovary ca. 1.3 mm. long, the style ca. 1.2 mm. long, the stigma peltate, ca. 0.4 mm. across, (?)3-radiate. Submature fruit ellipsoid, ca. 11 by 8.5 mm., apiculate, drying vinaceous-brown, finely and irregularly striate; outer layer not detaching cleanly from stone, ca. 0.8 mm. thick, compact; stone ellipsoid, ca. 9 by 6.5 mm., apiculate, the walls ca. 0.2 mm. thick, smooth, unmarked; spongy layer thin.

**DISTRIBUTION.** Vanua Levu, Fiji (MAP 38); known only from the type collection.

**ECOLOGY.** Forest patches in rolling grassland, 100–200 m. alt. Flowering and fruiting in December; submature fruit white.

*Calophyllum leucocarpum* can be recognized by its small leaves that dry umber and nitid and that have a prominent midrib on the upper surface; by the subsistent, more or less tomentose indumentum on its terminal bud, twig, and midrib, and on the basal part of its inflorescence; by its four-tepaled flowers with short styles; and by its small fruits that have a relatively thick outer layer and are white when ripe. The epithet *leucocarpum* means “white fruit”—appropriate for this species.

*Calophyllum leucocarpum* is superficially similar to *C. gracillimum* (from Malaya). The two species can be most readily separated by the indumentum



MAP 38. Distribution of *Calophyllum neo-ebudicum* (circles; not including doubtful records from the Celebes) and *C. caledonicum* (squares) in the western Pacific. Inset 1: *C. vitiense* var. *vitiense*. Inset 2: *C. cerasiferum* (circles) and *C. leucocarpum* (star in solid circle).

of the inflorescence and flowers: in *C. gracillimum* there are hairs on the pedicels, the backs of the tepals, and the anthers.

116. *Calophyllum articulatum* P. F. Stevens, sp. nov.

FIGURE 36, f-i.

A speciebus aliis *Calophylli* quibus laminis cordatis basibus habent in innovationibus basibus tumidis cum ramulis articulatis, fructu strato exteriore tenui (circa 0.6 mm. crasso), et putamine haud signato, differt.

Tree 8–25 meters tall, d.b.h. to 40 cm.; outer bark yellowish brown (grayish), cracked at first, becoming fissured; inner bark pale reddish to brown; latex clear.

Twigs flattened, 2–3.5 mm. across, obscurely 4- or 6-angled, drying pale to dark brown, subtomentose when young; axillary innovations lacking basal scars, but swollen at base; internodes (0.5–)1–3.5 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, inconspicuous; terminal bud plump, 2.5–3 mm. long, with subtomentose, brown indumentum (hairs, FIGURE 35, b–d), underdeveloped internode absent. Petiole 2–3.5 mm. long,  $\pm$  flat above and convex below, with few subsistent hairs; lamina elliptic or obovate to subtrapeziform, 2.3–7(–11) by 0.9–3.8(–6.5) cm.,  $\pm$  rounded at apex, cordate to narrowly rounded at base, broadly and distantly undulate but not recurved at margin, very coriaceous, drying chestnut above (midrib and margin notably paler) and umber below, glabrous at maturity, the midrib above gradually narrowed from base, almost flat to raised, surrounding lamina  $\pm$  raised, 0.3–0.6 mm. wide at midpoint, below slightly raised, striate, the venation subobscure above and subapparent below, raised, 4 to 7 (to 9) veins/5 mm., angle of divergence 40–55°. Infructescences from foliate axils, with scars of (?5 to) 7 to 9 flowers, unbranched, the axis 2.4–6.2 cm. long, glabrous, lowest internode 1.2–3.2 cm. long; bracts not known; pedicels 0.6–1.2 cm. long, glabrous. Flower not known. Fruit ellipsoid, ca. 1.15 by 0.9 cm., apiculate when young, becoming rounded, drying pruinose-brown, smooth; outer layer not detaching cleanly from stone, ca. 0.6 mm. thick, air spaces developing beneath skin; stone ellipsoid, ca. 9 by 7.5 mm., rounded at apex, the walls ca. 0.15 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Seram (West), Waiselang, 100 m., 23 June 1959, *Kuswata & Soepadmo* 219 (holotype, BO; isotypes, A, CANB, K, KEP, L, LAE, NY, P, SING).

DISTRIBUTION. The Moluccas (MAP 39).

ADDITIONAL SPECIMENS SEEN. **Moluccas**. AMBON: Waai, slope of Mt. Salahatu, 300–600 m., *Kuswata & Soepadmo* 301 (BO, L); Mt. Salhoetoe, *Teysmann s.n.* (BO).

ECOLOGY. Colline forest, 100–600 m. alt. Ripe fruit reported to be blue.

*Calophyllum articulatum* can be readily recognized by its very coriaceous leaf blades that are rounded to cordate at the base, its partly enclosed axillary buds, and its articulations where the axillary branches join the stem. The epithet *articulatum* (“jointed”) was chosen because of this last feature.

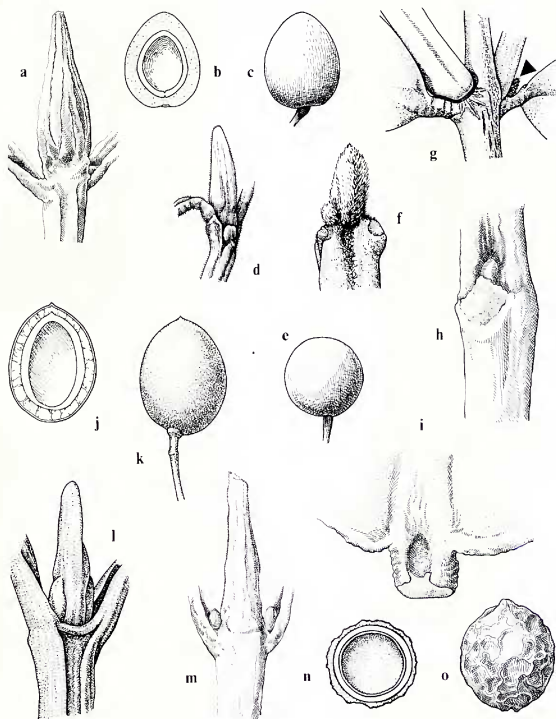
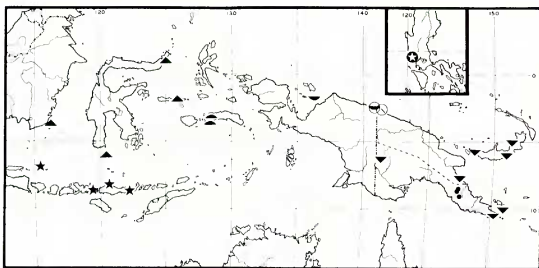


FIGURE 36. a, *Calophyllum* sp. 129 (bb 29806), terminal bud,  $\times 3$ . b-e, *C. collinum*. b, c, Stevens et al. 921, fruit,  $\times 1$ : b, longitudinal section; c, from outside. d, e, NGF 42992: d, terminal bud,  $\times 3$ ; e, fruit, from outside,  $\times 1$ . f-i, *C. articulatum* (Kuswata & Soepadmo 219): f, terminal bud,  $\times 6$ ; g, branch insertion,  $\times 3$ , arrow marks supernumerary axillary bud; h, axillary bud,  $\times 6$ ; i, leaf base,  $\times 6$ . j-l, *C. hirasimum* (Kanehira & Hatusima 13980). j, k, fruit,  $\times 1.5$ : j, longitudinal section; k, from outside. l, terminal bud,  $\times 6$ . m-o, *Calophyllum* sp. 121 (Merrill's collector 142). m, terminal bud,  $\times 6$ . n, o, fruit,  $\times 1$ : n, transverse section; o, from outside.



MAP 39. Distribution of *Calophyllum archipelagi* (stars), *Calophyllum* sp. 129 (erect triangles), *C. articulatum* (erect half-circles), *C. savannarum* (inverted half-circles), *C. laticostatum* (inverted triangles), *C. carriei* var. *carriei* (solid circles), and *C. carriei* var. *longigemmatum* (open circles) in Malaysia. Inset: *Calophyllum* sp. 121.

*Calophyllum articulatum* differs from both *C. venulosum* and *C. calcicola*, which may have at least superficially similar leaves, in having an inflorescence with more flowers (in both of the latter species, there are rarely more than five). The lowest internode of the inflorescence is about half the length of the entire axis and is much longer than the upper internodes (in the other two species the relationship is reversed). The swollen bases of the innovations, which then become noticeably constricted where they join higher-order branches, and the partly enclosed axillary buds, distinguish sterile material of *C. articulatum* from that of the other two species. Unlike *C. venulosum*, but like *C. calcicola*, the outer layer of the fruit is thin; however, *C. calcicola* has an inconspicuous submarginal vein that is lacking in *C. articulatum*.

The color of the dried leaf blade (especially in the type specimen), the articulations at the bases of the innovations, the partly enclosed axillary buds, and the midrib type suggest that *Calophyllum articulatum* is closely related to *C. savannarum*. However, the functional terminal bud, the cordate base of the leaf blade, and the inflorescence type of *C. articulatum* all readily distinguish the two species.

*Teysmann s.n.* has leaf blades that are up to 11 by 6.5 cm. and are broadly cordate at the base.

117. *Calophyllum savannarum* A. C. Smith, Jour. Arnold Arb. **22**: 352. 1941; P. F. Stevens, Austral. Jour. Bot. **22**: 394. 1974. TYPE: Netherlands New Guinea [Irian Jaya], Hollandia [Djajapura] and vicinity, 20–100 m., 29 June 1938, Brass 8888 (holotype, A; isotypes, BO, BRI, K, L, LAE). FIGURE 4, b–d.

Tree 10–12 meters tall, d.b.h. to 19 cm.; trunk and bark not known. Crown with hanging branches.

Twigs strongly flattened, 1–2.5 mm. across, 2-angled or rounded, drying (pale) brown, glabrous when mature; axillary innovations lacking basal scars, but swollen where joining stem; internodes 1.5–5 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, spreading, inconspicuous (hairs, FIGURE 35, e); terminal bud not seen, apparently not functional and soon falling off, underdeveloped internode 3–7(–13) mm. long. Petiole 0.7–1.5(–2) cm. long, slightly concave above, convex below, glabrous; lamina ovate to elliptic, (5.5–)7–12.5 by (2–)2.3–4.5 cm., cuneate to bluntly acuminate at apex, acute to decurrent at base, moderately and distantly undulate and slightly recurved at margin, coriaceous, drying chestnut to sepia above, shiny, midrib and margins (veins) notably paler, and umber to sepia below, glabrous, the midrib above narrowed gradually from base, raised, continuous with surrounding blade, 0.3–0.6 mm. wide at midpoint, below slightly raised, angled, venation apparent on both surfaces, raised, 5 to 7 veins/5 mm., angle of divergence 45–60°. Inflorescences from foliate axils, with 5 to 9 flowers, unbranched, the axis 3–4 cm. long, glabrous, lowest internode (0.3–)0.5–1.5 cm. long; bracts unknown; pedicels 1.1–1.7 cm. long, glabrous, somewhat incrassate in fruit. Flower (?)hermaphroditic; tepals 4, glabrous, the outer pair broadly ovate, ca. 5.5 by 5 mm., the inner pair  $\pm$  obovate, ca. 7 by 4 mm.; stamens 50 to 70, the filaments to 3 mm. long,  $\pm$  free, the anthers oblong, 2–2.7 mm. long, retuse at apex; ovary 1.2 mm. long, the style ca. 3 mm. long, the stigma peltate, ca. 1.5 mm. across, 3- to 5-radiate. Fruit ovoid, ca. 1.4 by 1.1 cm., rounded at apex, drying grayish olive, smooth; outer layer detaching cleanly from stone, 0.8 mm. thick, compact except for air spaces developing under skin; stone ovoid-ellipsoid, 1–1.1 by 0.6–0.7 cm., apiculate or rounded at apex, the walls ca. 0.15 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Northern Irian Jaya (MAP 39).

SELECTED SPECIMENS SEEN. **Papuaia.** IRIAN JAYA. Geelvink Bay: Seroei, Eil. Japen, Mariatoc, 500 m., *bb* 30477 (A, SING). Djajapura: Hollandia [Djajapura], "Dok 2," *BW* 3915 (A, BO, K, L, LAE, P, SING).

ECOLOGY. Secondary forests on steep slopes; principal component of forest clumps in secondary savanna; 20–500 m. alt. Flowering in August; fruiting June and August (fruit blue).

*Calophyllum savannarum* is an easily recognized species, even when sterile, because of its nonfunctional terminal bud and consequent profuse branching, and its axillary shoots that are noticeably swollen at the base but lack the scars of perulae. The axillary buds, which are almost glabrous, are inconspicuous due to the way they are protected (FIGURE 4, b, c). Its leaf blades are coriaceous, dry dark brown (but with lighter-colored midrib, margins, and veins), and have rather distant, steeply ascending veins. The epithet *savannarum* ("of the savannas") reflects the habitat of this species around Djajapura.

*Calophyllum savannarum* is most closely related to *C. articulatum*. For the differences between the two species, see *C. articulatum*.

118. *Calophyllum vitiense* Turrill, Jour. Linn. Soc. Bot. **43**: 17. 1915. TYPE: Fiji [Viti Levu, Mba], Nandarivatu, some three miles [4.8 km.] along the road to Suva, 2 Dec. 1906, *im Thurn* 297 (lectotype,  $\kappa$ ; isolectotype,  $\kappa$ ).

Tree 5–30 meters tall, d.b.h. to 50 cm.; trunk without buttresses; outer bark brown, slightly fissured or flaking, exposing greenish yellow patches; latex brownish, smelling strongly of green ginger; sapwood grayish brown; heartwood deep reddish brown with dark brown lines.

Twigs slightly flattened, 1.7–4 mm. across, persistently 4-angled to 4-alate (with additional, less prominent raised lines, rarely coarsely striate), drying dark brown, farinose to subtomentose when young; axillary innovations lacking basal scars; internodes 0.5–3 cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long,  $\pm$  spreading; terminal bud plump (conical), (4.5–)7–12 mm. long, with brown to grayish, subcrustose to short-tomentose indumentum (hairs, FIGURE 35, f, g, k, l; cf. 35, n), underdeveloped internode absent (to 3 mm. long). Petiole 0.5–3 cm. long, broadly and deeply concave above, convex below, glabrous when mature; lamina ovate to elliptic or oblong, (4–)11–21 by (1.2–)3–5.8 cm., shallowly retuse to acuminate at apex, acute to attenuate (rarely broadly rounded and then attenuate) at base, undulate and at most slightly recurved at margin, thinly coriaceous, drying sepia to grayish sepia above, margin and midrib paler, and umber below, sparsely farinose on midrib below when young, the midrib above gradually narrowed from base, depressed, clearly demarcated from lamina by often raised margins, 0.25–0.7 mm. wide at midpoint, center clearly sulcate, becoming raised toward apex, below raised, angled toward apex, striate toward base, the venation subobscure to apparent above and below, raised, (3 to) 5 to 9 (to 11) veins/5 mm., angle of divergence 65–80°. Inflorescences from foliate axils, with 5 to 13 (to ca. 21) flowers, unbranched, the axis (1.3–)4–12 cm. long, sparsely brown-farinose to tomentose toward base, or subglabrous, lowest internode (0.3–)0.7–2.2(–4.5) cm. long; bracts elliptic to ovate, 2.5–5 by 1.7–2 mm., caducous; pedicels (0.4–)1–3.2 cm. long, glabrous or sparsely farinose. Flower (?)hermaphroditic; tepals (7 or) 8 (to 12), the outer pair broadly ovate to suborbicular, 4.5–6 by 2.8–3.5 mm., the inner ones elliptic to oblong, 7.5–12.5 by 3.5–10 mm.; stamens 275 to 340, the filaments to 5.5 mm. long, the anthers oblong to elliptic, 0.5–1 mm. long, retuse at apex; ovary 2.5–2.8 mm. long, the style 2.7–5 mm. long, the stigma peltate, 0.9–1.3 mm. across, 3- or 4-lobed. Fruit  $\pm$  ellipsoid, 2.2–3.3 by 1.8–2.2 cm., rounded at apex, drying dark Indian red, pruinose or not,  $\pm$  broadly wrinkled, the wrinkles sharp and deep in submature fruit, rounded and shallower in mature fruit; outer layer not detaching cleanly from stone, ca. 0.5(–1.5) mm. thick,  $\pm$  fibrous, with numerous air spaces; stone ellipsoid, 2–2.7 by 1.5–2 cm., rounded at apex, the walls 1–3 mm. thick, smooth, unmarked, with basal plug ca. 10 mm. across; spongy layer thin.



Key to the Varieties of *Calophyllum vitiense*

1. Terminal bud (6-)8-12 mm. long, usually with subcrustaceous indumentum; lamina acute to acuminate at apex. . . . . 118a. var. *vitiense*.
1. Terminal bud 4.5-7 mm. long, usually short-tomentose; lamina shallowly retuse to rounded (acute) at apex. . . . . 118b. var. *amblyphyllum*.

118a. *Calophyllum vitiense* Turrill var. *vitiense*

- C. vitiense* Turrill; Watkins, Dept. Agr. Jour. Agr. Fiji 31: 15. fig. 1961; Parham, Fl. Fiji Is. 134. 1964, *ibid.* ed. 2. 192. 1972; A. C. Smith & Darwin, Jour. Arnold Arb. 55: 227. figs. 9, 11. 1974, *pro majore parte*.
- C. tenuicrustosum* A. C. Smith & Darwin, Jour. Arnold Arb. 55: 236. fig. 22. 1974, *pro parte*. TYPE: Fiji, Viti Levu, Mba, slopes of Mt. Nairoso, eastern flank of Mt. Evans range, 700-1050 m., 28 April 1948, A. C. Smith 4058 (holotype, A; isotypes, K, NY, P, US).
- C. spectabile* auct., non Willd.; A. Gray, U. S. Expl. Exped. 15(1): 218. 1854, *pro parte*, Proc. Am. Acad. 5: 315. 1862, Bonplandia 10: 34. 1862; Seem. Fl. Vit. 11. 1865; Horne, Year Fiji, 258. 1881.
- C. (?) polyanthum* auct., non Wall. ex Choisy vel *C. (?) lanceolatum* auct., non Bl.; Seem. Viti, 433. 1862.

Tree 5-30 meters tall, d.b.h. to 50 cm.

Twigs with brown, farinose to tomentellous indumentum when young; terminal bud plump, (6-)8-12 mm. long, with brown to grayish, crustaceous (rarely puberulo-tomentose) indumentum. Lamina ovate to elliptic or suboblong, (4-)11-21 by (1.2-)3-5.8 cm., acute to acuminate at apex, acute to attenuate (very rarely rounded) at base. Inflorescence axis (2.5-)5-12 cm. long, glabrous or farinose at base; pedicels (0.4-)1.7-3.2 cm. long.

DISTRIBUTION. The Fiji Islands (MAP 38).

SELECTED SPECIMENS SEEN. **Pacific Islands.** FIJI. Viti Levu. Mba: vicinity of Nandarivatu, 900 m., Gillespie 4229 (A, BO, GH, K, NY, P, US); Nausori Highlands, Mt. Evans Range, 579 m., Damanu E118 (K); Nasama Creek, 457 m., C.S.I.R.O. S 1404/6 (K). Serua: Nabukavesi, 90 m., C.S.I.R.O. S 1404/4 (K); Naboutini, 150 m., C.S.I.R.O. S 1404/15 (K). Namosi: sine loco, FDA 14236 (A, CHR, K, NY). Tailevu: E. of Wainimbuka R., near Ndakuivuna, A. C. Smith 7201 (GH, K, P, US); Colo[Tholo]-i-Suva, Watkins 713 (K); Tamavua, Gillespie 2407 (BO, GH, K, NY, P, US); Kalambo, FDA 16410 (MASS); Naisinu, 150 m., Gillespie 3647 (BISH). Ovalau: Mt. Korotolutolu, W. of Thawathi, A. C. Smith 8021 (GH, K, NY, P, US); W. of Lovoni valley, ridge S. of Mt. Korolevu, A. C. Smith 7542 (GH, K, NY, P, US); E. of Lovoni valley, A. C. Smith 7269 (GH, K, NY, P, US). VANUA LEVU. Mathuata: near Lambasa, Greenwood 507 (K), Mt. Numbuloa, E. of Lambasa, A. C. Smith 6362 (A, K, US), Motuyagaikaveta, 90 m., C.S.I.R.O. S 1404/2 (K); Natidoyaga, Fl. Fiji [FDA] 12910 (K); Seaqaqa, coffee plantation, Fl. Fiji [FDA] 13935 (CHR, K, LAE). Sine loco: Howard 187 (US).

ECOLOGY. Dense or open forest, rarely in grassland; 90-1050 m. alt. Flowering August, and October to January; fruiting mostly May to August (fruit purple).

LOCAL USE. The wood is used for general construction (A. C. Smith & Darwin, *loc. cit.*).

118b. *Calophyllum vitiense* Turrill var. *amblyphyllum* (A. C. Smith & Darwin) P. F. Stevens, comb. et stat. nov.

*C. amblyphyllum* A. C. Smith & Darwin, Jour. Arnold Arb. 55: 232. figs. 17, 18. 1974, *pro minore parte*. TYPE: Fiji, Viti Levu, Serua, hills west of Waivunu creek, between Ngaloa and Korovou, 50–150 m., 23 Sept. 1953, A. C. Smith 9243 (holotype, US; isotypes, GH, K, NY, P).

*C. tenuicrustosum* A. C. Smith & Darwin, Jour. Arnold Arb. 55: 236. 1974, *pro minore parte*.

Tree 9–15 meters tall.

Twigs short-tomentose when young; terminal bud plump to conical, 4.5–7 mm. long, with short, tomentose (rarely subcrustaceous), brown indumentum, hairs to ca. 0.25 mm. long. Lamina oblong to subelliptic, (4.3–)6.5–13.6 by 2.7–4.6(–5.2) cm., minutely retuse to rounded (acute) at apex, acute at base, or toward base broadly rounded and at base short-attenuate. Inflorescence axis (1.5–)2.3–6.5 cm. long, short-tomentose toward base; pedicels 0.9–2 cm. long.

DISTRIBUTION. Fiji, Viti Levu.

ADDITIONAL SPECIMENS SEEN. **Fiji.** VITI LEVU. Serua: near Taunovo Creek, E. of Wainiyambia, s.l.–50 m., A. C. Smith 9576 (GH, K, NY, P, US); Queen's road, littoral forest, FDA 7036 (BISH). Rava: Qoyo F.R., 45 m., FDA 13764 (BISH); Goya, 30 m., *Damanu* E121 (K).

ECOLOGY. Forests near coast, sometimes by sea; below 50 m. alt. Flowering in November.

The epithet *amblyphyllum* means “blunt leaf,” so is appropriate for this taxon.

*Calophyllum vitiense* is a fairly easily recognizable species, having characteristic leaf blades that dry sepia on the upper surface, with the margin and the depressed midrib brighter brown; the venation is rather distant and clear. The fruit has a thin (usually ca. 0.5 mm.) outer layer. The upper surface of the leaf blade is minutely bullate when viewed at a magnification of  $\times 30$  or greater; this is most clearly visible in the younger leaves. The epithet *vitiense* is derived from a Latinized form of “Fiji.”

The description of the bark is taken from Watkins (*loc. cit.*) and is probably that of *Calophyllum vitiense* var. *vitiense*.

The specimens of *Calophyllum amblyphyllum* included in *C. vitiense* have the characteristic leaf type described above; however, the majority of the specimens included in this species by Smith and Darwin (*loc. cit.*) are here placed in *C. cerasiferum* and *C. neo-ebudicum*. *Calophyllum vitiense* var. *amblyphyllum* differs from var. *vitiense* in having leaf blades that are more or less rounded at the apex, rather than acute to acuminate, and a short terminal bud that often, but not always (e.g., FDA 13764), has short, tomentose

indumentum. The specimens cited under *C. vitiense* var. *amblyphyllum* were all collected at low altitudes, while var. *vitiense* is usually a plant of colline forest.

There is substantial similarity between the large-leaved species of *Calophyllum* from Fiji and Samoa (*C. vitiense*, *C. neo-ebudicum*, *C. cerasiferum*, and perhaps also *C. inophyllum*). All have similar hairs, fruits with stones that have basal plugs, flowers with usually eight tepals, and internodes that are rather short for such large-leaved plants. *Calophyllum vitiense* has sepia-drying leaves with rather distant venation and a minutely bullate upper epidermis; *C. neo-ebudicum* has rather shiny leaves drying other than sepia and with dense venation drying a different color; *C. cerasiferum* has leaves drying dull sepia and with dense, concolorous venation. *Calophyllum inophyllum* is the only species of the group with leaves that are basically rounded at the apex, and it has rather distant venation.

*Calophyllum tenuicrustosum* was characterized by its flowers, which have more than eight tepals, and by its fruits, which have a thin outer layer. It was compared with *C. cerasiferum*, in part probably because Howard 195, which was included in *C. tenuicrustosum*, is *C. cerasiferum*. Although the type specimen of *C. tenuicrustosum* has a rather narrowly elliptic leaf blade, it has all the other leaf characteristics of *C. vitiense*, including the minutely bullate upper surface. The thin outer layer of the fruit is also characteristic of *C. vitiense*. The fruits of *C. tenuicrustosum* are rather small for those of *C. vitiense* (in the lowest part of the size range for the species), but as the illustration in Smith and Darwin (*loc. cit.*) shows, they are immature: they lack an embryo, and the woody layer is poorly organized. The fruits of FDA 7036 are somewhat more mature and have a basal plug.

It is not certain that *Calophyllum vitiense* grows on Vanua Levu; I have seen only the single unlocalized specimen cited above from there.

The three complementary sheets of *im Thurn* 297 at Kew were designated the lectotype of *Calophyllum vitiense* by Smith & Darwin (*loc. cit.*); Turrill also cited a sterile specimen (*Seemann* 47) in the protolog.

119. ***Calophyllum neo-ebudicum*** Guillaumin, Jour. Arnold Arb. **12**: 227. 1931; St. John & A. C. Smith, Pacific Sci. **25**: 326. 1971; A. C. Smith & Darwin, Jour. Arnold Arb. **55**: 230. figs. 14–16. 1974. TYPE: New Hebrides, Aneityum, Anelgauhat Bay, 25 m., 4 Feb. 1929, *Kajewski* 705 (lectotype, P; isoelectotypes, A, BO, BRI, NY, US).
- C. samoense* Christophersen, Bishop Mus. Bull. **128**: 147. fig. 20. 1935; Yuncker, Bishop Mus. Bull. **184**: 52. 1943; Parham, New Zealand Dept. Sci. Industr. Res. Inf. Ser. **85**: 121. 1972; A. C. Smith & Darwin, Jour. Arnold Arb. **55**: 229. figs. 12, 13. 1974. TYPE: Samoa, Savaii, Vaipouli-Manase, 100 m., 21 Sept. 1929, *Christophersen* 720 (holotype, BISH (n.v.); isotypes, A, US).
- C. pseudovitiense* P. F. Stevens, Austral. Jour. Bot. **22**: 389. fig. 12. 1974. TYPE: Solomon Islands, Guadalcanal, Gold Ridge, 690 m., 16 Oct. 1962, BSIP 648 coll. Whitmore (holotype, LAE; isotype, SING).
- C. spectabile* auct., non Willd.; Planchon & Triana, Ann. Sci. Nat. Bot.

- IV. 15: 266. 1862, *quoad Abadie* 29; Drake, Illus. Fl. Insul. Maris Pacifici, fasc. 6. 116. 1890, *pro parte*; Drake, Fl. Polynésie Franç. 10. 1893; Hemsley, Jour. Linn. Soc. Bot. 30: 169. 1894; Reinecke, Bot. Jahrb. 25: 656. 1898; Denkschr. Akad. Wiss. Wien. Math.-Naturw. 81: 313. 1910; Lloyd & Aiken, Bull. Lloyd Libr. Bot. 4: 72. 1934; Burrows, Bishop Mus. Bull. 138: 136, 154. 1936; Yuncker, Bishop Mus. Bull. 184: 52. 1945.
- C. vitiense* auct., non Turrill; Setchell, Carnegie Inst. Wash. Publ. 431: 69. 1924; A. C. Smith, Jour. Arnold Arb. 22: 347. 1941; F. S. Walker, Forests Brit. Solomon Is. Protect. 124. 1948; T. C. Whitmore, Guide Forests Brit. Solomon Is. 78. 1966, Gard. Bull. Singapore 22: 12. 1967; Sykes, New Zealand Dept. Sci. Industr. Res. Bull. 200: 100. fig. 9. 1970; Foreman, Check List Vasc. Pl. Bougainville, 42, 86, 87. fig. 1972; A. C. Smith & Darwin, Jour. Arnold Arb. 55: 227. fig. 10. 1974, *pro parte*.
- C. (?)inophyllum* auct., non L.; Guillaumin, Jour. Arnold Arb. 12: 227. 1931.
- C. amblyphyllum* A. C. Smith & Darwin, Jour. Arnold Arb. 55: 232. fig. 19. 1974, *pro minore parte*.
- C. leptocladum* A. C. Smith & Darwin, Jour. Arnold Arb. 55: 221. 1974, *pro minore parte*.
- Calophyllum* sp. Burkill, Jour. Linn. Soc. Bot. 35: 27. 1901.

Tree 6–58 meters tall, d.b.h. to 184 cm.; trunk rarely with buttresses to 1.3 meters tall; outer bark gray to yellowish mottled at first, with brown and pinkish patches intermingled, later brown, deeply fissured, not hoop marked, the inner surface blackish; under bark reddish; inner bark reddish, fibrous; latex yellow (rarely cream), clear, but tending to become turbid, sticky. Crown pyramidal when young, becoming cauliflower shaped with age.

Twigs slightly flattened, 1.5–4 mm. across, obscurely 4-angled, drying brown to blackish, puberulent to short-tomentose when young; axillary innovations lacking basal scars; internodes 0.7–4 cm. long; uppermost pair of axillary buds rounded, to 2 mm. long,  $\pm$  erect; terminal bud plump (rarely conical), 0.4–1.5 cm. long, with grayish to ferrugineous, puberulent to short-tomentose indumentum (hairs, FIGURE 35, h, j, m–o), underdeveloped internode to 4 mm. long. Petiole 0.6–3.7 cm. long, broadly concave above, convex below, often drying blackish, glabrous when mature; lamina rather narrowly ovate to elliptic (rarely suboblong), (4–)5–19.5 by 1.5–7.3 cm., acuminate (obtus) at apex, cuneate to narrowly acute or attenuate at base, undulate but slightly or not recurved at margin, coriaceous, drying olivaceous to umber above, often nitid, margin and midrib often paler, and fulvous to near dark olive-buff below, glabrous to subpersistently puberulent on midrib below, the midrib above gradually narrowed from base, depressed, margins usually raised, becoming raised toward or above midpoint, (0.1–)0.2–0.5(–0.8) mm. across at midpoint, below raised, angled toward apex, striate toward base, the venation  $\pm$  apparent above and below, raised, latex canals  $\pm$  raised or not, 7 to 14 veins/5 mm., angle of divergence 60–80°. Inflorescences from upper foliate axils (rarely terminal), with 7 to 17 flowers, unbranched (very rarely with

3-flowered branches to 1 cm. long, or flabellate), the axis 1.5–9.2(–13) cm. long, puberulent or short-tomentose, especially toward base (glabrous above), lowest internode 0.4–3.3(–4.5) cm. long; bracts ovate, to 5 mm. long, not persistent; pedicels 0.7–2 cm. long, glabrous to puberulent. Flower (?) hermaphroditic; tepals 8 (to 12), the outer pair ovate to suborbicular, 2.5–5.5 by 2.7–4 mm., back sometimes puberulent toward base, the inner ones elliptic to obovate, 7–10 by 3.5–6 mm.; stamens 150 to 275, the filaments to 5.5 mm. long, the anthers elliptic or suboblong, 0.4–1.2 mm. long, retuse at apex; ovary 1.5–2.5(–3) mm. long, the style 2.5–3 mm. long, the stigma peltate or infundibular, 0.5–1 mm. across, 3- or 4-radiate or not. Fruit ovoid or ellipsoid to subspherical, 2.1–3.7(–4.3) by 1.5–2.8 cm., ± rounded at apex, drying vinaceous-brown to blackish and pruinose, broadly and ± deeply wrinkled to smooth; outer layer usually not detaching cleanly from stone, (0.5–)1–3 mm. thick, compact, usually with air spaces developing adjacent to skin and stone (throughout); stone ovoid or ellipsoid to subspherical, (1.5–)1.8–3.2(–4) by (1–)1.3–2.5 cm., rounded to obtusely pointed at apex, the walls (0.7–)1.3–2.1(–3.3) mm. thick, smooth, unmarked, with basal plug 6–10 mm. across; spongy layer thin.

DISTRIBUTION. (?) Celebes, New Britain, and Bougainville, to the New Hebrides, Fiji, Samoa, and Tonga (MAP 38).

SELECTED SPECIMENS SEEN. **Celebes.** SALAJAR: Lembang, Djampea, 245 m., *bb* 2947 (?) (BO). **Papua and adjacent islands:** see *C. pseudovitiense*, Stevens, *loc. cit.* **Pacific Islands.** FIJI. Moala: near Maloku, 200 m., *A. C. Smith* 1334 (BO, GH, K, NY, P, US). Naitamba: sine loco, *FDF* L12384 (BISH). Mango: sine loco, 50–100 m., *Bryan* 569 (A). Viti Levu. Mba: mountains near Lautoka, 360 m., *Greenwood* 907 (A); Mt. Evans Range, 610 m., *Greenwood* 1232 (US). Sine loco, *Gräffe s.n.* (NY, W). Ovalau: sine loco, *Horne* 43 (K). Koro: main ridge, 300–500 m., *A. C. Smith* 1047 (BO, GH, K, NY, US). Vanua Levu. Mathuata: Mt. Numbiloa, E. of Lambasa, 500–590 m., *A. C. Smith* 6449 (A, K, NY, P, US). Thakaundrove: near Valeni, *FDA* 15722 (?) (BISH); valley of Navonu Creek, 305 m., *Howard* 104 (BISH, CHR, US). **TONGA.** Vava'u, sine loco, *Crosby* 204 (K); Kao, *Yuncker* 15883 (BM, U, US, W); 'Eua, near center of island, 240 m., *Yuncker* 15326 (BISH, BM, US). **HORNE ISLANDS AND SAMOA:** see *C. samoense*, Smith & Darwin, *loc. cit.* Also, Samoa: Upolu, Vaiaberg, *Rechinger* 1399 (W); bei Tiari, *Rechinger* 1317 (W), bei Utumapu, *Rechinger* 941 (W). **NIUE:** Ana, near Hakapu-Liku road, *Sykes* 821A (BISH, CHR); Huvalu Forest, *Sykes* 399 (CHR). **NEW HEBRIDES:** see *C. neo-ebudicum*, Smith & Darwin, *loc. cit.*

ECOLOGY. Usually primary lowland to colline rainforest, to 825 m. alt. Often abundant, especially in Solomon Islands and New Hebrides, favoring ridges and other well-drained habitats. In New Hebrides common in Kauri (*Agathis*) forests; *Agathis* regenerates in gaps resulting from death of mature *C. neo-ebudicum* (Beveridge, 1975). Sometimes on coralline limestone in Fiji and the Horne Islands, rarely so elsewhere. Flowering in Solomon Islands February, April, May, July to December; elsewhere September to February (flower scented). Fruiting more or less year around in both areas (fruit pale green at first, turning bluish to purple-black when ripe).

Details of the establishment of *Calophyllum neo-ebudicum* on Kolombangara (the Solomon Islands) are given by Whitmore (1974, as *C. vitiense*). The fruits are well dispersed, and the seedling grows to adult size in closed forest as well as in gaps.

**GERMINATION AND YOUNG PLANT.** The radicle pushes out a basal plug during germination. The seedling has two (Sykes 823), three, or four pairs of leaves; when there are four pairs, some leaves are always very much reduced (1–4 mm. long) and soon fall off; the internodes are 1–2.2 cm. long. Subsequent growth is erect, the terminal bud is functional, and the internodes gradually become longer. (Sykes 823; LAE 50491.)

**LOCAL NAME AND USES.** “Gwarangwaro” (Kwara’ae). Through much of the range of the species, the timber is used for building canoes; more locally it is used for building houses or in making spears or bowls. Hair oil is made from the flowers (Fauro Islands). In Malaita small saplings, with the outer layer of the bark removed to give bright, saffron-colored sticks, are reported to have been used in bride purchase.

*Calophyllum neo-ebudicum* can be recognized by its frequently dark-drying twigs and leaf stalks and by its ovate-elliptic lamina, the upper surface of which often dries somewhat nitid greenish and has a depressed midrib. The predominantly eight-tepaled flowers have small anthers and a short (less than 3 mm.) style. The spherical to ovoid-ellipsoid fruits dry more or less smooth and have a rather thick outer layer and a moderately thick stone; the stone has a basal plug. Indumentum on parts of the plants other than the terminal bud is usually inconspicuous. The specific epithet is derived from a Latinization of “New Hebrides.”

The single specimen cited from the Celebes, *bb* 22947, may not belong here. The specimen is sterile, and fertile material, preferably in fruit, is needed to confirm the record.

A number of specimens from throughout the range of the species have terminal inflorescences, but are not otherwise unusual. *FDA* 15722, cited by Smith and Darwin as *C. leptocladum*, has very small, coriaceous leaf blades that dry the color of those of *C. leptocladum* but have the midrib of those of *C. neo-ebudicum*; its terminal bud and infructescence are also like *C. neo-ebudicum*. In vegetative characters *BSIP* 8876 is like *C. neo-ebudicum*, but the thin, sharply wrinkled outer layer of the fruit is like that of *C. inophyllum*; fruit shape is intermediate between those of the two species. *Greenwood* 1232 has exceptionally thick-walled stones (measurements in parentheses); the specimen consists only of fallen leaves and fruit.

*Calophyllum pseudovitiense* and *C. neo-ebudicum* cannot be separated since they have similar leaves, inflorescences, and flowers, and the anthers of both are small.

Smith and Darwin (*loc. cit.*) separated *Calophyllum samoense* from *C. neo-ebudicum* predominantly on fruit characters. *Calophyllum neo-ebudicum* had fruits that were definitely longer than broad and a firmly fibrous mesocarp 1–4 mm. thick that did not fall away from the endocarp (their terminology)

and leave air cavities, while *C. samoense* had ovoid or subglobose fruits and a fibrous-spongy mesocarp 3.5–6 mm. thick with prominent cavities. The fruits of *C. neo-ebudicum* figured by Smith and Darwin (from *Kajewski* 399) are immature; those of *Kajewski* 953, which are submature, have cavities immediately under the skin. The fruits of *Bristol* 2248 (originally determined as *C. samoense*) have a subcompact outer layer with cavities under the skin and adjacent to the stone, although in most other fruiting specimens of *C. samoense* the cavities have invaded the entire outer layer. All these specimens have ripe or nearly ripe fruits, and the development of cavities seems to be a part of the ripening process. However, both in *C. neo-ebudicum* from the Solomon Islands (e.g., *BSIP* 79; seed possibly not developing) and in specimens placed by Smith and Darwin (*loc. cit.*) in *C. amblyphyllum*, but properly identified as *C. neo-ebudicum* (e.g., *A. C. Smith* 6449; nearly mature), the outer layer may be almost compact. Although the fruits of *C. samoense* tend to be broader than the others, this is not an absolute difference, specimens with similar fruits having been collected from the Solomon Islands (e.g., *BSIP* 6255, Ulawa Island). Of the specimens originally included in *C. amblyphyllum* but correctly placed here, *A. C. Smith* 6449 (Fiji) has fruits about 1¼ times longer than broad, while those of *Yuncker* 15583 (Tonga) are almost spherical. Fruits from Niue seem to be longer than broad (*Sykes* 821A). Specimens of all taxa discussed have stones with thick walls and a plug at the base that presumably becomes detached during germination, and the ripe fruits are reported to be (pruinose) dark purple, black, or sometimes brown. There are no vegetative differences between the specimens of the various taxa placed in synonymy, and in most details of flower and inflorescence they are also similar. However, in specimens of *C. neo-ebudicum* the anthers are 0.4–0.8 mm. long, while in those referable to *C. samoense* they are (0.5–)0.7–1.2 mm. (Anther length is known from only a single Fijian collection (*Gräffe s.n.*, from Viti Levu); the anthers are ca. 1 mm. long.) Specimens in flower have not yet been collected in Niue. Smith and Darwin (*loc. cit.*) note that *C. neo-ebudicum* and *C. samoense* were reported to have differences (unspecified) in general aspect, bark, and wood, and that *C. samoense* grew on coralline limestone, while *C. neo-ebudicum* never did. However, on Samoa itself *C. samoense* does not seem to have been collected on limestone, and it certainly grows on other rocks.

Although specimens assignable to *Calophyllum samoense* show certain differences when compared to other specimens placed in *C. neo-ebudicum*, such as somewhat longer anthers, relatively broader fruits, and twigs that more frequently dry brown, there is overlap in these characters between specimens from Samoa, Tonga, and the Horne Islands and those from the rest of the range of the species. Furthermore, the length of the anthers is not known in some parts of the range of the species (see above). It thus seems unwise to recognize any infraspecific taxa within *C. neo-ebudicum* at present.

Variation in hair type in *Calophyllum neo-ebudicum* is considerable. The variation in *BSIP* 429 alone bridges the gap between the large, erect hairs of *Kajewski* 2643 and the more normal, small, papillate, adaxially curved

hairs of most other specimens, including those that have been called *C. samoense* (FIGURE 35, h, n).

I have not seen *Abadie* 29, on which Planchon and Triana (*loc. cit.*) based their record of *Calophyllum spectabile* in the Society Islands, but it probably belongs here.

It should be noted that *Calophyllum neo-ebudicum* must be lectotypified on the sheet of *Kajewski* 705 in the Muséum d'Histoire Naturelle at Paris (cf. Smith & Darwin, *loc. cit.*). Guillaumin worked on the set of *Kajewski*'s specimens deposited in the herbarium there.

120. *Calophyllum cerasiferum* Vesque, *Epharmosis* 2: t. 32. 1889, in C. DC. Monogr. Phanerog. 8: 585. 1893; Parham, Pl. Fiji Is. ed. 2. 192. 1972; A. C. Smith & Darwin, Jour. Arnold Arb. 55: 235. figs. 20, 21. 1974. TYPE: Fiji [Viti Levu, Namosi Province], Voma Peak, 24 August 1860, *Seemann* 49 (lectotype, G; isolectotypes, BM, G, GH, K, P).

*C. burmannii* auct., non Wight; Seem. Bonplandia 9: 254. 1861, Viti, 433. 1862; Horne, Year Fiji, 258. 1881; Drake, Illus. Fl. Insul. Maris Pacifici, fasc. 6. 116. 1890.

*C. burmannii* Wight var. *parvifolium* auct., non Wight; Seem. Fl. Vit. 11. 1865.

*Calophyllum* sp. nov. Horne, Year Fiji, 258. 1881.

*C. amblyphyllum* A. C. Smith & Darwin, Jour. Arnold Arb. 55: 232. 1974, *pro parte*.

Tree 12.5–25 meters tall, d.b.h. to 60 m.; trunk (?) without buttresses; outer bark yellowish, rough to smooth, with wide vertical erodes (?fissures); inner bark red; latex yellow (*A. C. Smith* 4944), white (*A. C. Smith* 8378), or opaque (*Howard* 336).

Twigs slightly flattened, (1.7–)2.5–4.5(–7) mm. across,  $\pm$  4-angled at first, becoming coarsely striate, with ca. 8 raised lines, drying dark brown when young, later brown and yellowish white, sparsely farinose when young; axillary innovations lacking basal scars; internodes 0.5–2.5(–3.5) cm. long; uppermost pair of axillary buds rounded, to 2 mm. long,  $\pm$  spreading; terminal bud plump, 0.5–1.6 cm. long, with subcrustose, grayish brown indumentum (hairs, FIGURE 35, q–s, z), underdeveloped internode absent. Petiole (0.5–)0.8–2(–2.8) cm. long, flat or broadly to rather narrowly concave above, convex or  $\pm$  angled below, often drying blackish, glabrous when mature; lamina elliptic to oblong, (3.2–)4.5–16 by (1.5–)2–6.8 cm. (ca. 15 by 4 cm.), shortly and rather abruptly acuminate to rounded at apex, attenuate at base, or broadly rounded toward base and attenuate at very base, undulate and slightly to strongly recurved at margin, coriaceous, drying  $\pm$  sepia above and honey to umber below, farinose on midrib below when young, the midrib above  $\pm$  abruptly narrowed near or gradually narrowing from base, subdepressed, the margins raised or not, becoming level or slightly raised, 0.15–0.5(–0.8) mm. wide at midpoint, below strongly raised, angled toward apex, striate toward base, the venation subobscure to subapparent above and below, slightly raised, (6 to) 11 to 18 veins/5 mm., angle of divergence 65–80(–85)°.



Inflorescences from foliate axils, with (3 to) 5 to 9 (to 13) flowers, unbranched (rarely with 3-flowered branches up to 3.5 cm. long), the axis (1.1-)2-5.8(-10) cm. long, farinose (rarely subglabrous) when young, lowest internode 1-3 (-4.5) cm. long; bracts ovate, ca. 5 mm. long, soon deciduous; pedicels 0.4-2.3 cm. long, sparsely farinose when young. Flower (?)hermaphroditic; tepals 8 to 12, the outer pair broadly ovate to suborbicular, 4.75-7.5 by 4.5-6.5 mm., the next pair broadly ovate to oblong or elliptic, 4.5-9 by 4-7 mm., the inner ones ovate to elliptic or oblong, 6.5-11 by 2.5-7 mm.; stamens (80 to) 120 to 250, the filaments to 4.5 mm. long, connate for up to 1 mm., the anthers elliptic to suboblong, 0.3-1.4 mm. long, retuse at apex; ovary 1-2 mm. long, the style 1-2.5 mm. long, the stigma peltate to infundibular, ca. 1 mm. across, not lobed. Fruit spherical to ellipsoid, 1.8-3.2 by 1.7-2.4 cm., rounded to subacute at apex, drying vinaceous-brown to orange-cinnamon, smooth to sharply wrinkled; outer layer detaching  $\pm$  cleanly from stone, (0.8-)1-2.5 mm. thick, compact but skin often breaking off easily in ripe fruits; stone ellipsoid to subspherical, (1.6-)2.1-2.5 by 1.5-2.1 cm.,  $\pm$  rounded at apex, the walls 1-1.6 mm. thick, smooth, unmarked, with basal plug to 1 cm. across; spongy layer thin.

DISTRIBUTION. Fiji Islands (MAP 38).

ADDITIONAL SPECIMENS SEEN. **Pacific Islands.** FIJI. Sine loco: *Horne s.n.* (GH). Viti Levu. Mba: vicinity of Nandarivatu, S. slopes of Mt. Ndelainathovu, 870-890 m., *A. C. Smith 4944* (A, K, NY, P, US), Sovutuwambu, 750-800 m., *Degener 14664* (A, K, NY), Waimoqi, 823 m., *FDF 1075* (K), Vunidawa Path, 823 m., *Vaughan 3431* (BM, K), Waimongge Creek, 610 m., *Berry 82* (MASS, US), *85* (MASS), *88* (MASS), *Damanu K88* (CHR, US). Nandronga & Navosa: S. of Mt. Victory [Tomanivi], 914 m., *FDA 14292* (BISH, K); track to Vanua Levu village, 610 m., *Berry 79* (CHR, MASS); Rairamatuku Plateau, between Nandrau and Nanga, 725-825 m., *A. C. Smith 5461* (A, K, NY, P, US). Serua: Nabukelevu, *FDA 15654* (CHR, MASS); Naboutinini, 150 m., *Damanu R22* (K), *FDF 573* (BISH); Ngaloa, 210 m., *Damanu G22* (K, NY), *FDF 574* (BISH). Namosi: hills bordering Wainavindrau Creek, near Wainimakatu, 150-250 m., *A. C. Smith 8525* (GH, K, NY, P, US), *8553* (GH, K, NY, US); hills near Navua R., 200-300 m., *Greenwood 1036* (A, K); Mt. Vakarongasiu, *Gillespie 3267* (BISH); Mt. Voma Track, 610 m., *FDA 604* (SUVA). Naitasiri: Nanubu R., Rewasau, 914 m., *Howard 308* (SUVA, US); Mendrausuthu Range, 751 m., *FDA 15463* (CHR, MASS, SUVA), *15471* (CHR, LAE); Mt. Naitarandamu, *Gillespie 3232* (GH). Sine loco, *Macgillivray & Milne 67* (K). Vanua Levu. Mathuata: Sasa [Tikina], *Howard 195* (MASS). Thakaundrove: Yanawai R. region, Mt. Kasi, 300-430 m., *A. C. Smith 1789* (?) (BO, GH, K, NY, P, US). Taveuni: near Crater Lake E. of Somosome, 600-900 m., *A. C. Smith 8378* (GH, K, NY, P, US); Wailotua-Wainibuka, *Howard 336* (CHR); E. of Wairiki, valley between Mt. Manuka and Mt. Koroturanga, 600-700 m., *A. C. Smith 8286* (GH, K, NY, P, US). Sine loco: *Milne 244* (K).

ECOLOGY. Colline and lower montane forest, on ridges and summits at higher altitudes (stunted tree in exposed conditions); 150-1250 m. alt. Flowering March, June, and November; fruiting June, and August to November (fruit reddish tinted—*A. C. Smith 8525*).

LOCAL USE. The wood is good timber and is used in construction.

Although *Calophyllum cerasiferum* is a variable species, it can be characterized by its rather plump terminal bud with more or less crustaceous, grayish brown indumentum; its twigs, which dry yellowish brown and coarsely striate; its coriaceous leaf blades, which have dense venation and dry sepia on the upper surface; and its fruits, which have a more or less compact outer layer and a thick-walled stone with a basal plug. The epithet *cerasiferum* ("bearing cherries") alludes to the dried fruits, which are about the size of large cherries.

The circumscription of *Calophyllum cerasiferum* has been somewhat troublesome. It was originally decided to recognize two taxa: one including the large-leaved and -fruited specimens, with leaf blades sometimes strongly recurved at the margins and acuminate at the apex; the other, *C. cerasiferum* sensu stricto, including the smaller-leaved and -fruited specimens with the leaf blades only slightly recurved at the margin and more or less rounded at the apex. The fruits of the former group of specimens are wrinkled, while those of the latter are smooth. However, there are all intermediates in leaf size and type: *Damanu* G22 (large, strongly revolute blades); *A. C. Smith* 8525 (large, not very revolute blades); *A. C. Smith* 5461 (smaller blades); *A. C. Smith* 4944, *FDF* 1075, *FDA* 14292, and *Berry* 79 (small leaves acute at the apex; fruit wrinkled); *Seemann* 49 (leaves obtuse, fruit  $\pm$  smooth). There is considerable variation in the width of the leaf blade in both small- and large-leaved specimens. In details of terminal bud, hair type, leaf (apart from its size and apex), and fruit (except for the surface), the specimens are all basically similar.

*A. C. Smith* 4944 is the only large-leaved specimen that has flowers; the flowers have eight tepals, and the filaments appear to have a yellow pigment. Of the smaller-leaved specimens, *Howard* 195, *Berry* 82, *Berry* 88, and *FDA* 15463 have flowers; all have ten to twelve tepals, and there is no pigment in the filaments. Within these latter specimens there is considerable variation in anther size: the anthers of *Berry* 88 are up to 1.5 mm. long, while those of *FDA* 15463 are only 0.3–0.5 mm.

Thus, despite the considerable variation in the group, all specimens have a basic similarity. In some characters the variation is continuous and is independent of variation in other characters; in others (notably those of the flower), there is too little material to evaluate the variation. Hence, it seems sensible to adopt broad limits for *Calophyllum cerasiferum*, at least for the time being.

*Greenwood* 1036, which was apparently collected from a young tree of *Calophyllum cerasiferum*, has leaves with a lamina up to ca. 22.5 by 5.5 cm. *A. C. Smith* 1789 is included in *C. cerasiferum* only with hesitation. With its broad midrib (figure in parentheses in the description above) and its rather distant venation (6 to 8 veins/5 mm.) it approaches *C. vitiense*; however, it has a coriaceous lamina with a recurved margin, and its twigs, although much stouter than those in other specimens of either species, are more similar to those of *C. cerasiferum* than to those of *C. vitiense*. Its

inflorescences are extremely robust (measurements in parentheses in the description above).

*Calophyllum cerasiferum* has been lectotypified on the duplicate of *Seemann* 49 once in the Boissier Herbarium in Geneva and now in the general herbarium there. It seems that Vesque based his original illustration of *C. cerasiferum* on this specimen, rather than on the duplicate at Kew Herbarium. Thus, the typification of *C. cerasiferum* by Smith and Darwin (*loc. cit.*) has to be slightly emended.

121. *Calophyllum* sp.

FIGURE 36, m-o.

Tree ca. 12 meters tall; trunk and bark unknown.

Twigs slightly flattened, 1.2–2.5 mm. across, obscurely 4-angled, drying blackish, grayish- to brown-puberulent; axillary innovations lacking basal scars; internodes 0.5–2.5 cm. long; uppermost pair of axillary buds ca. 1.5 mm. long, rounded, subspreading; terminal bud plump, 5–9 mm. long, with grayish to brown, crustaceous to puberulent indumentum (hairs, FIGURE 35, p; cf. 35, o), underdeveloped internode to 2 mm. long. Petiole 0.3–1.2 cm. long, shallowly concave above, convex below, glabrescent; lamina ovate to rhombiform, 2.8–8.6 by 1.3–2.5 cm., acuminate at apex, acute to narrowly acute at base, somewhat undulate and slightly recurved at margin, coriaceous, drying  $\pm$  sepia above and sepia to sabelline below, glabrous when mature, the midrib above narrowing gradually from base,  $\pm$  level or slightly depressed, 0.3–0.4 mm. wide at midpoint, below rather inconspicuous, raised, striate, the venation above and below subobscure to apparent, raised, 10 to 15 veins/5 mm., angle of divergence 55–70°. Inflorescences from foliate axils, with 7 to 15 flowers, unbranched, the axis 1.4–3 cm. long, puberulent, lowest internode 3–7 mm. long; bracts unknown; pedicels 0.5–1 cm. long, puberulent. Flower (?)hermaphroditic; tepals 8, the outer pair broadly ovate, 4.5–5 by 3.5–4.5 mm., the next pair elliptic, 7 by 5 mm., to suborbicular, 5.3 by 6 mm., the inner ones elliptic, 6–7.5 by 3–4 mm.; stamens 120 to 145, the filaments to 4.5 mm. long, the anthers oblong, ca. 1 mm. long, retuse at apex; ovary ca. 1.5 mm. long, the style 2.5–3 mm. long, the stigma peltate, 0.6–0.8 mm. across, obscurely radiate. Fruit ellipsoid, 1.9–2.3 by 1.4–1.8 cm., persistently apiculate or not, drying vinaceous-brown,  $\pm$  wrinkled; outer layer detaching  $\pm$  cleanly from stone, ca. 1 mm. thick; stone ellipsoid, 1.3–1.8 by 1.3–1.5 cm., rounded at apex, the walls 0.4–0.9 mm. thick, ca. 2 mm. at base and ca. 0.25 mm. to one side of base, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Philippine Islands, Luzon (MAP 39).

SELECTED SPECIMENS SEEN. **Philippines.** LUZON. Bataan: Lamao R., Mt. Mariveles, *Whitford* 257 (F, G, K, NY, P, US), 1017 m., *Williams* 424 (GH, K, NY, US); Lamao F.R., *BS* 1577 (US).

ECOLOGY. Lower montane forest, ca. 1000 m. alt. Flowering in January; fruiting March, May, July, October, and November.

*Calophyllum* sp. 121 can be characterized by its plump terminal bud and

its medium-sized lamina that is acute to acuminate at the apex, with the midrib on the upper surface drying reddish brown. The inflorescence is rather short, and the flowers have eight tepals. The fruit is relatively large (ca. 2 cm. long) and has a rather thin outer layer and a stone that lacks a basal plug.

Although in general appearance *Calophyllum* sp. 121 is similar to *C. neo-ebudicum*, the stone lacks the basal plug characteristic of that species; the hairs suggest a comparison with *C. whitfordii* (cf. FIGURES 35, p, and 43, q, s, y). Until *Calophyllum* sp. 121 is better known, it is premature to describe it formally.

In leaf and twig there is considerable variation among the specimens cited. *BS 1577* and *Whitford 1190* have short, rather thickly coriaceous leaf blades with rather dense venation, and stout twigs with short internodes, while *Williams 424* has longer, thinner leaf blades with more distant venation, and thinner twigs with longer internodes. There is no comparable variation in the fruit, and in all specimens the midrib on the upper surface of the lamina narrows gradually from the base and is reddish.

122. *Calophyllum caledonicum* Vieill. ex Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 291. 1862; Vesque, Epharosis 2: t. 3. 1889, in C. DC. Monogr. Phanerog. 8: 546. 1893; Guillaumin, Ann. Mus. Colon. Marseille, II. 9: 102. 1911; Baker f. Jour. Linn. Soc. Bot. 45: 273. 1921; C. T. White, Jour. Arnold Arb. 7: 95. 1926; Daniker, Mitt. Bot. Mus. Zurich 112: 271. 1933; Guillaumin, Fl. Nouv. Caléd. 217. 1948; Sarlin, Bois Forêts Nouv. Caléd. 206. pl. 91. 1954. TYPE: New Caledonia, bords des ruisseaux à Gatope, anno 1886, *Vieillard 175* (lectotype, p; ?)isolectotypes, A, K, NSW).

*C. montanum* Vieill. ex Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 292. 1862; Vieill. Ann. Sci. Nat. Bot. IV. 16: 74. 1862; Schlechter, Bot. Jahrb. 39: 193. 1906; Guillaumin, Ann. Mus. Colon. Marseille, II. 9: 102. 1911; Sarlin, Bois Forêts Nouv. Caléd. 308. pl. 93. 1954. TYPE: New Caledonia, montagnes à Balade, *Vieillard 174* (holotype, p; isotypes, A, Fl, G, L, P).

Tree 3–10(–220) meters tall, d.b.h. to 30 cm.; trunk without buttresses; outer bark brown to gray, fissured, thick; wood reddish.

Twigs slightly flattened, 3–4.5 mm. across, 4- (very rarely 2-)angled when young, soon becoming coarsely striate, drying brown when young, later often with yellowish patches, sparsely farinose-puberulent when young; axillary innovations lacking basal scars; internodes 0.7–3.5 cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long, suberect, inconspicuous; terminal bud plump, 0.75–1.2(–1.8) cm. long, with short-tomentose to subcrustaceous, grayish to brown indumentum (hairs, FIGURE 35, t–w), underdeveloped internode absent (to 3.5 mm. long). Petiole (0.2–)0.5–1.5(–2.5) cm. long, flat to broadly concave above, convex below, glabrous when mature; lamina oblong to elliptic, 5–14.3 by 1.8–3.6(–4.5) cm., rounded (rarely acute to subacuminate) at apex, acute to broadly rounded at base, slightly undulate,

slightly or not recurved at margin, coriaceous, drying umber to olivaceous above and below, glabrescent or sparsely and subpersistently farinose on midrib below, the midrib above narrowing rather quickly near base, broadly depressed at first, 0.2–0.6 mm. wide at midpoint, becoming raised in top  $\frac{1}{3}$  of lamina, below raised, striate (rarely angled), the venation above and below apparent, raised, (6 to) 8 to 13 veins/5 mm., angle of divergence 70–85(–90)°. Inflorescences from foliate axils (very rarely terminal), with (5 to) 11 to 25 flowers, unbranched (rarely with 5-flowered branches up to 4 cm. long), the axis (3–)5–10(–21) cm. long, transiently puberulent or subglabrous, lowest internode 1.5–4(–8) cm. long; bracts narrowly ovate to elliptic, to 11 by 3 mm., not persistent; pedicels 0.7–2(–3.5) cm. long, glabrous to puberulent. Flower (?)hermaphroditic; tepals (9 to) 12 (to 16), the outer pair  $\pm$  orbicular, 4–8 by 2.7–7 mm., the inner ones elliptic to obovate, (7–)10–12.5 by (2–)3.5–7 mm., outer tepals larger and inner ones glabrous; stamens 330 to 430, the filaments to 4.5 mm. long, the anthers elliptic to suboblong, 0.7–1.1 mm. long, rounded to retuse at apex; ovary ca. 1.8 mm. long, the style 2–3 mm. long, the stigma subpeltate, ca. 0.7 mm. across. Fruit spherical to ellipsoid, 1.7–2.7 by 1.2–2.2 cm., rounded to obtuse at apex, drying  $\pm$  vinaceous-brown, smooth or broadly wrinkled; outer layer detaching cleanly from stone, 1–4.5(–10) mm. thick, compact, air spaces developing under skin or not; stone spherical to ellipsoid, 1.2–1.8 by 0.9–1.6 cm., rounded to acute at apex, the walls 0.2–1 mm. thick, smooth, unmarked, at base poorly defined semifibrous (?)plug ca. 5 mm. across; spongy layer thin.

DISTRIBUTION. New Caledonia (MAP 38).

SELECTED SPECIMENS SEEN. New Caledonia: Balade, *Vieillard* 175 (G, P); sommet de Puébo, *Vieillard* 174 (G, GH, K, L); Wagap, *Vieillard* 173 (P); So. base of Mt. Kaala, *McKee* 7985 (CANB, K, L, P, US); vallée de Pouai (entre Ta et la Ouaimé), 20–100 m., *McKee* 15618 (P); Chagrin Mine, Koumac Distr., *McKee* 7996 (A, CANB, K, L, P, US); Hienghiène, *McKee* 26918 (P); Koné, Pinjen, 10 m., *McKee* 29360 (P); bords de la Oumbea, au dessus de Koé, *Balansa* 1335 (G, K, P, US); Bourail, col des Rouseilles, *Sarlin* 151 (P); Haute Boulari, flancs du Pic Buse, 500 m., *Viro*t 522 (A, P); banks of Toutouta R. near junction of the Kalouéhola, 50 m., *McKee* 7732 (A, CANB, K, L, NSW); Kanala, *Vieillard* 175 (NSW, NY, P); Bergen am Ngoye, 100 m., *Schlechter* 15241 (BM, E, F, G, K, L, M, NSW, P, W); am Südwestfusse des Mt. Humboldt, *Daniker* 573 (P); Païta, *Le Rat* 82 (P); forêts de la Caricouye, 200–400 m., *Franc* 39 (A, G, NY); Noumea, *Gandoger* s.n., June 1906 (M); montagnes de St. Louis, *Pompéry* s.n., anno 1881 (P); Col de Plum, *Baumann-Bodenheim* 16088 (A); route de la montagne des Sources, 500 m., *McKee* 24840 (P); Plaine des Lacs, Mois de Mai forest, 250–350 m., *Buchholz* 1383 (A, BISH, K, P, US); Route de Yaté, *Sarlin* 165 (P); Prony, 2 m., *Balansa* 584 (BM, K, P); Baie de Sud, *Raoul* s.n. (P).

ECOLOGY. On serpentine rocks by rivers, on schists away from rivers; to 500 m. alt. Flowering November to February, and August (flower sweetly scented (like those of oranges—*Viro*t 1340)); fruiting September to January (fruit blue to black, glaucous).

GERMINATION AND YOUNG PLANT. The seedling has three pairs of leaves separated by well-developed internodes at least 1 cm. long. (McKee 24841.)

*Calophyllum caledonicum* can be recognized by its plump terminal bud; stout twigs, which dry yellowish and striate when old; more or less oblong leaves that have clear venation and a depressed midrib; and flowers, which have at least nine tepals. The specific epithet comes from the Roman name for Scotland.

*Calophyllum caledonicum* is perhaps related to the *C. vitiense*-*C. cerasiferum* group of species; particularly in its terminal bud, twig, and flower, it is most similar to *C. cerasiferum*. However, it is not clear that *C. caledonicum* has a plug at the base of the stone like the other members of the *C. vitiense* group.

Vesque (1893, *loc. cit.*) thought that *Calophyllum inophyllum* and *C. caledonicum* were close, since both have flowers with a large number of tepals. However, *C. inophyllum* usually has only eight tepals, and it further differs from *C. caledonicum* in having a shorter terminal bud, a more or less obovate, thinner lamina, longer pedicels, and a larger fruit that differs in structure and is pale green when ripe. The two species are probably not particularly closely related (but see below).

#### Variation within *Calophyllum caledonicum*

Planchon and Triana noted that *Calophyllum montanum* had leaves in whorls of four, or almost in whorls, or sometimes only opposite. On some sheets bearing the same number as the lectotype of *C. caledonicum* (Vieillard 175; see below), the leaves are alternate. Few subsequent collections have whorled leaves. Those of Sarlin 278 are in whorls of four, while those of McKee 20797 and McKee 15618 are in whorls of three. Five shoots of McKee 20797 were seen at Paris: two of the five had opposite leaves, and three had leaves in threes; all shoots came from the same tree (McKee, pers. comm.). The arrangement of the leaves in whorls on one of the shoots had broken down in an older part of the shoot, with scars of alternate, opposite, and "adjacent" leaves (i.e., leaves borne two at a node, but adjacent, rather than opposite, in insertion). Although specimens with whorled leaves tend to have long petioles and blades that are more or less acuminate at the apex, there are intermediates in these characters as well. The fruits of McKee 20797 are broadly ellipsoid, ca. 2.4 cm. long, and with a stone ca. 1.7 cm. long. The as yet immature fruits of McKee 15618 are ovoid and ca. 2.7 cm. long, but the stone is only ca. 1.4 cm. long, the outer layer being up to 1 cm. thick—over twice as thick as is usual in the species. Although the whorled arrangement of the leaves of the specimens discussed is a remarkable character, it is unstable and does not correlate with other characters. *Calophyllum montanum* is left in synonymy under *C. caledonicum*, as was first suggested by Vesque (1893, *loc. cit.*).

Virot 511 and 522, both sterile specimens, have the midrib on the lower surface of the lamina angled rather than striate; the young stem is strongly two- (vs. four-)angled.

## Nomenclature

The sheet of *Vieillard 175* at Paris with a locality label "bords des ruisseaux à Gatope" is designated the lectotype of *Calophyllum caledonicum*. Other sheets, possibly isoelectotypes, bear a label "bords d'un torrent à Gatope."

Possible Hybridization with *Calophyllum inophyllum*

Two specimens collected from the southern end of New Caledonia (Goro, *Sarlin 182* (p); Baie du Prony, *Balansa 585* (p)), are intermediate between *Calophyllum caledonicum* and *C. inophyllum*. The lamina is up to 20 by 5–8 cm. and has 5 to 8 veins/5 mm. It is more coriaceous and narrower than is usual for *C. inophyllum*, but in both venation density and midrib type it approaches that species. Both specimens are in fruit (those of *Balansa 585* are mature, the stone being filled by the embryo); the fruit is of a lighter color than is usual in *C. caledonicum*. The fruits approach those of *C. inophyllum*, although the spongy layer does not seem to be particularly thick. *Sarlin 182* has on its field label "tamanu de bord de mer," the French name for *C. inophyllum*!

123. ***Calophyllum carrii*** P. F. Stevens, Austral. Jour. Bot. **22**: 360. fig. 2. 1974. TYPE: Papua [Northern Province], Isuarava, 3500 feet [1530 m.], 15 Feb. 1936, *Carr 15599* (holotype, LAE; isotypes, A, CANB, K, L, NY, SING).

Tree; for details of trunk and bark, see varieties.

Twigs slightly flattened, 3.5–7 mm. across,  $\pm$  4-angled, or with ca. 8 raised lines, becoming striate when older, drying grayish brown, puberulo-farinoso when young; axillary innovations lacking basal scars; internodes 1–3 cm. long; uppermost pair of axillary buds rounded, ca. 1.5 mm. long, suberect, inconspicuous; terminal bud plump, 1–3 cm. long, with grayish brown, crustaceous indumentum (hairs, FIGURE 35, aa, bb, ff; also submoruloid), underdeveloped internode to 3 mm. long. Petiole 1–3 cm. long, broadly concave above, convex to angled below, glabrescent; lamina obovate to suboblong, (5.5–)7–12 by 2.9–6 cm., obtuse to shallowly retuse at apex, acute at base, undulate and recurved at margin, marginal thickening sometimes up to 1 mm. wide, coriaceous, drying sabelline above and fulvous-umber below, subpersistently puberulent to furfuraceous on midrib below, the midrib above narrowing gradually from base, depressed at first, 0.2–1.5 mm. wide at midpoint, becoming raised in top half of leaf, below raised, rounded to striate, the venation rather obscure above,  $\pm$  apparent below, raised, 7 to 13 (to 15) veins/5 mm., angle of divergence 65–75°. Inflorescences from lower foliate (rarely defoliate) axils, with 5 to 18 flowers (with 3-flowered branches to 1.2 cm. long), the axis 3.3–4.5 cm. long, farinose-puberulent, lowest internode 2–4 mm. long; bracts unknown; pedicels 0.5–1.9 cm. long, farinose-puberulent. Flower known only in bud; tepals 8 (rarely 6), the two outer broadly ovate, ca. 6.5 by 5.5 mm., sparsely farinose on back at very base; stamens 90 to 120, the anthers oblong, 0.5–1 mm. long,  $\pm$  retuse at apex; ovary ca.

1.8 mm. long, the style unknown, the stigma excentrically peltate, ca. 1.5 mm. across. Immature fruit (from var. *longigemmatum*) subspherical, ca. 1.8 cm. long, drying smooth.

Key to the Varieties of *Calophyllum carrii*

1. Twigs 3.5–4.5(–5.5) mm. across; terminal bud 1–2.2 cm. long; lamina lacking an obviously thickened margin. . . . . 123a. var. *carrii*.
1. Twigs 4.5–7 mm. across; terminal bud 2–3 cm. long; lamina with thickened margin ca. 1 mm. wide. . . . . 123b. var. *longigemmatum*.

123a. *Calophyllum carrii* P. F. Stevens var. *carrii*

Tree ca. 35 meters tall, d.b.h. to 100 cm.; trunk with buttresses to 0.9 mm. tall; outer bark dark brown, fissured; under bark light brown; latex golden, clear.

Twigs 3.5–4.5(–5.5) mm. across,  $\pm$  4-angled or with ca. 8 raised lines; terminal bud 1.3–2.2 cm. long; lamina with slightly recurved margin, marginal thickening not obvious.

DISTRIBUTION. Central and Northern provinces of Papua New Guinea (MAP 39).

SELECTED SPECIMENS SEEN. **Papuasiasia**: see Stevens, *loc. cit.*

ECOLOGY. Lower montane rain forest, 1050–1525 m. alt. Flowering in February (late bud).

- 123b. *Calophyllum carrii* P. F. Stevens var. *longigemmatum* P. F. Stevens, Austral. Jour. Bot. **22**: 361. 1974. TYPE: Nederlands Nieuw-Guinea [Irian Jaya], Hollandia, mouth of Tami River, 15 m., 8 July 1956, BW 2813 coll. Schram (holotype, LAE; isotypes, BO, CANB, K, KEP, L, SING).

Tree ca. 30 meters tall; trunk without obvious buttresses; outer bark dark gray, flaking off in irregular, rectangular scales; under bark reddish and cream mottled; inner bark creamy red; latex yellow.

Twigs 4.5–7 mm. across, usually with 8 raised lines; terminal bud 2–3 cm. long; lamina with strongly recurved margin, marginal thickening ca. 1 mm. wide.

DISTRIBUTION. Mainland New Guinea; known only from a small area along the northern coast (MAP 39).

SELECTED SPECIMENS SEEN. **Papuasiasia**: see Stevens, *loc. cit.*

ECOLOGY. Lowland rainforest, 15–300 m. alt.

Conoidal galls ca. 1 mm. tall sometimes occur on the lower surface of the lamina (BW 2813).

The epithet *longigemmatum* refers to the distinctive terminal buds of this variety.



*Calophyllum carrii* can be recognized by its long, plump terminal bud, obovate to suboblong leaf blades with the midrib on the upper surface depressed for at least half its length, and flower with (usually) eight tepals. Its indumentum is not well developed, and the older twigs at least are striate. The specific epithet commemorates C. E. Carr, who collected the type specimen during his fatal trip to New Guinea.

Although the two varieties are readily distinguished by the characters given above, neither is well known.

124. *Calophyllum collinum* P. F. Stevens, sp. nov.

*Calophyllum* sp. D, aff. *C. sil* Lauterb.; P. F. Stevens, Austral. Jour. Bot. 22: 397. 1974.

A speciebus aliis Calophylli in internodiis brevibus 0.3–2 cm. longis, lamina parva costa supra valde sulcata venulis 11 usque ad 20 per 5 mm., fructu subsphaerico strato exteriori 1.5–3 mm. crasso e putamine haud munde secedenti, differt.

Tree 22–36 meters tall, d.b.h. to 85 cm.; trunk without buttresses; outer bark brown (gray), fissures at first short and distinct, becoming confluent, inner surface brown (orange-brown); under bark red; inner bark red or reddish; latex yellow, clear, viscous (becoming green).

Twigs slightly flattened, 1.2–3.5 mm. across, strongly 4-angled, often with 4 additional raised lines, drying dark brown, transiently subfarinose to subpersistently tomentose; axillary innovations lacking basal scars; internodes 0.4–2 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, subspreading; terminal bud plump, 6–9 mm. long, with brown, subtomentose to subcrustaceous indumentum (hairs, FIGURE 35, x, y, cc-ee), underdeveloped internode to 1 mm. long. Petiole (0.45–)0.6–1.2 cm. long, broadly concave above and convex below, glabrescent to subpersistently tomentose; lamina obovate to elliptic (rarely suboblong), (1.8–)2.3–8 by (1–)1.3–4.5 cm., rounded to subretuse or subcuneate at apex, acute to cuneate at base, slightly undulate and not recurved or slightly so at margin, coriaceous, drying umber to olivaceous above and fulvous to olivaceous below, transiently farinose to subpersistently puberulo-tomentose on midrib below, the midrib above gradually narrowed from base, strongly sulcate but at least margins raised, 0.2–0.4 mm. wide at midpoint, becoming raised toward apex, below raised, striate, the venation obscure to subapparent on both surfaces, raised to  $\pm$  flat, 11 to 20 veins/5 mm., angle of divergence 65–80°. Infructescences from foliate axils along twigs, with scars of 7 to 21 flowers, unbranched, farinose to subtomentose, lowest internode 1–10 mm. long; bracts not known; pedicels 4–9 mm. long, glabrous. Flower not known. Fruit subspherical (ovoid), 1.2–1.8 by 1.1–1.7 cm., rounded (rarely acute—*Stevens et al.* 921) at apex, drying brown, smooth; outer layer not detaching cleanly from stone, 1.5–3 mm. thick, compact apart from air spaces developing under skin; stone subspherical to ellipsoid, 0.9–1.4 by 0.8–1 cm., rounded (rarely obtuse) at apex, the walls 0.3–0.5 mm. thick, to 0.7 mm. thick at base, smooth, unmarked; spongy layer thin.

TYPE: Papua, Western District, Ningerum, 110 m., 29 August 1970, *NGF 42992* coll. *Henty & Barlow* (holotype, A; isotypes, K, L, LAE, SING).

DISTRIBUTION. Eastern New Guinea (MAP 41).

ADDITIONAL SPECIMENS SEEN. **Papuasias.** IRIAN JAYA. Snow Mountains: Bernhard Camp, Idenburg R., 550 m., *Brass & Versteegh 13576* (A, L). PAPUA NEW GUINEA. Morobe: near Garaina, 520 m., *NGF 45057* (A, E, K, L, LAE, M, SING). Western: 8 km. from Kiunga, 25 m., *Stevens et al. 888* (A), 890 (A); 24 km. from Kiunga, 30 m., *Stevens et al. 921* (A).

ECOLOGY. Colline forest or lowland forest with colline aspect, 25–520 m. alt. Fruiting March, July, and August (fruit blue to blackish—field notes of *NGF 45057* mention dark green fruit, but it is likely that these would finally turn bluish).

*Calophyllum collinum* can be recognized by its short internodes, its strongly four-angled twigs that usually have an additional four raised lines, and its small, oblong-obovate leaf blades with a strongly sulcate midrib and rather dense venation (11 to 20 veins/5 mm.). Its fruits have a thick outer layer that is compact except for air spaces that sometimes develop under the skin. The species looks like a plant from forests at higher altitudes, as Y. Lelean remarked when we first found the plant; this suggested the specific epithet.

*Calophyllum collinum* is a fairly common tree around Kiunga, especially noteworthy because of its clean, brown-colored bole that becomes deeply fissured only in very large specimens. Its relationships are not clear (see also Stevens, *loc. cit.*), but it can be readily distinguished from *C. sil* by the characters given in the diagnosis. Although the high-altitude variant of *C. sil* may have a midrib similar to that of *C. collinum*, it has larger leaves with less dense venation and twigs with longer internodes.

125. *Calophyllum costatum* J. F. Bailey, Queensland Agr. Jour. 5: 392. *pl.* 136. 1899 (1 Oct.); F. M. Bailey, Queensland Fl. 1: 104. 1899 (Dec.), Comprehens. Catal. Queensland Pl. 54. *fig.* 40. 1913. TYPE: Australia, Queensland, Evelyn [North Kennedy], 6 July 1894, *J. F. Bailey s.n.* (holotype, BRI; isotype, LAE (frag.)).

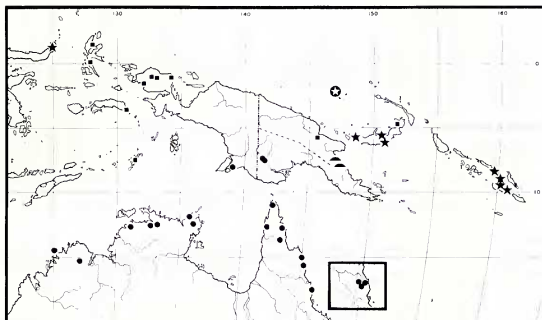
Tree to 25–33 meters tall, d.b.h. to 60 cm.; trunk without buttresses; outer bark dark brown or dark grayish, flaky or peeling off and cracked only in places, inner bark pink, layered, fibrous; latex pink-cream to whitish (turning brown on exposure (*Hyland 8912*)).

Twigs flattened, 2–4 mm. across, at most obscurely 4-angled, drying brown when young, whitish gray to yellowish white when older, subpersistently puberulent; axillary innovations lacking basal scars; internodes 0.5–2(–3) cm. long; uppermost pair of axillary buds pointed, to 3.5(–6.5) mm. long, erect, usually inconspicuous; terminal bud plump, 6.5–11 mm. long, with brownish, puberulo-tomentose indumentum (hairs, FIGURE 35, gg, hh), underdeveloped internode 1–3(–6) mm. long. Petiole 0.7–1.9 cm. long, broadly and shallowly concave above, convex below, glabrous; lamina elliptic to obovate, 4.7–8.8 by 2.2–3.9 cm., subacute to rounded at apex, acute to cuneate at base, distantly

and shallowly undulate but not recurved at margin, thinly coriaceous, drying umber above and slightly paler below, subpersistently farinose on midrib below, the midrib above narrowing gradually from base, strongly sulcate in bottom  $\frac{1}{3}$  of lamina, becoming raised, 0.2–0.3 mm. wide at midpoint, below raised, obscurely angled to striate, the venation above and below  $\pm$  clear, raised (rarely subobscure), 6 to 11 (to 14) veins/5 mm., angle of divergence 55–65°. Inflorescences from foliate axils, with 5 to 7 flowers, unbranched, the axis to 1.7 cm. long, puberulent, lowest internode ca. 8 mm. long; bracts ovate, to 8 mm. long, deciduous; pedicels 5–7 mm. long, puberulent. Flower (?)hermaphroditic; tepals 8, the outer pair ovate, ca. 7.5 by 6.5 mm., puberulent on back, the inner ones suborbicular, ca. 7 by 7 mm., outer pair puberulent dorsally down middle; stamens 95 to 140, the filaments to 2.5 mm. long, the anthers oblong, ca. 2 mm. long, acute at apex; ovary ca. 1.3 mm. long, the style unknown, the stigma peltate, ca. 1 mm. across. Fruit ellipsoid to ovoid, 2.8–3.5 by 2.3–3.8 cm.,  $\pm$  acute at apex, drying  $\pm$  vinaceous-brown, shallowly to rather sharply and deeply longitudinally wrinkled; outer layer detaching cleanly from stone, 1–2.5 mm. thick, compact; stone ellipsoid to ovoid, 2.3–3 by 1.9–2.2 cm., subacute to rounded at apex, the walls 1.2–1.5 mm. thick, to 3 mm. thick near base, smooth, unmarked, apparently with basal plug 3 mm. across; spongy layer (?)thin.

DISTRIBUTION. Northeastern Queensland, Australia (MAP 40).

SELECTED SPECIMENS SEEN. **Australia.** QUEENSLAND: Bellenden Kerr, 1075 m., *L. S. Smith* 14698 (BRI); Ravenshoe, *Manuell* 41 (BRI); Middle Creek, *Herb. Flecker* 6605 coll. *Flecker*; Atherton, *Rhys s.n.*, Feb. 1916 (BRI); Evelyn,



MAP 40. Distribution of *Calophyllum sil* (circles), *C. sil* variant (squares), *C. leleanii* (stars), *C. waliense* (star in solid circle), and *C. streimannii* (half-circles) in Malaysia. Inset: *C. costatum*.

*J. F. Bailey s.n.*, 15 April 1908 (K); S.F.R. [State Forest Reserve] 265 (near Crater), 1000 m., *Stocker 670* (A, CANB, K, KEP, LAE); S.F.R. [State Forest Reserve] 1203, Dirran, 1140 m., *Irvine 1203* (A, K, LAE); Boonjie L.A. [Logging Area], 680 m., *Hyland 8912* (A); Cook Distr., Hugh Nelson Range, *L. S. Smith 10507* (A).

ECOLOGY. Canopy tree of colline forest, 680–1140 m. alt. Flowering in November; fruiting January and March.

*Calophyllum costatum* can be recognized by its plump, moderate-sized terminal bud; its fairly small lamina that is more or less cuneate at the apex and has relatively clear and distant venation; and its rather large fruits (ca. 3 cm. long) that are broadly wrinkled. The outer layer of the fruit is comparatively thick (1–2.5 mm. across); the stone is thick walled and may have a basal plug. The midrib of the dried leaf is very prominent, and this fact suggested the specific epithet.

*Calophyllum costatum* is perhaps related to *C. obscurum* (q.v.).

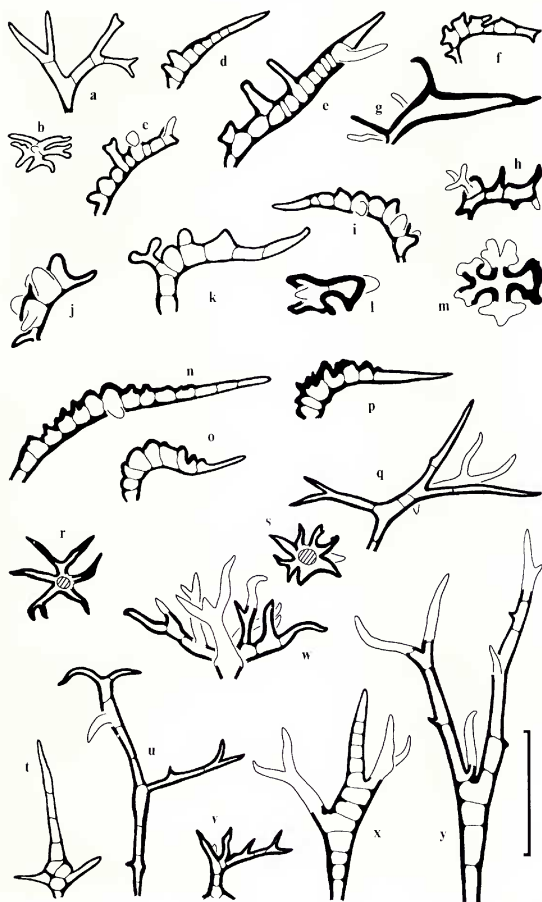
The original description of *Calophyllum costatum* must be attributed to Bailey *filius*, whose publication antedates that of his father by two months.

126. *Calophyllum obscurum* P. F. Stevens, Austral. Jour. Bot. **22**: 380, fig. 10. 1974. TYPE: Solomon Islands, Malaita, Are Are District, west coast, Kiu, 13 Feb. 1963, *BSIP 3875* (holotype, LAE; isotypes, K, L, SING).

Tree to 30 meters tall, d.b.h. to 90 cm.; outer bark yellow to gray-brown, scaly, fissured; latex yellow, opaque.

Twigs slightly flattened, 2–2.5 mm. across, 4-angled, drying grayish brown, subpersistently grayish farinose-puberulent; axillary innovations lacking basal scars; internodes 0.5–1.75(–3) cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long,  $\pm$  spreading, inconspicuous; terminal bud plump, 0.7–1(–1.7) cm. long, with subcrustaceous, grayish indumentum (hairs, FIGURE 37, a, b), underdeveloped internode 1–4 mm. long. Petiole 0.9–2.5 cm. long, flat to shallowly concave above, convex below, persistently farinose; lamina elliptic, ovate, or obovate, 7–11.5 by 3.3–6 cm., obtuse to subacuminate at apex, acute at base, undulate but slightly recurved at margin, coriaceous, drying near umber above and sepia below, subpersistently farinose on midrib below, the midrib above narrowing gradually from base, rather indistinct, margins slightly raised near base, 0.25–0.35 mm. wide at midpoint, becoming

FIGURE 37. Hairs (from terminal bud, unless otherwise noted). a, b, *Calophyllum obscurum* (*BSIP 7741*): b, from above. c–f, *C. sil*: c, d, *NGF 33731*; e, *NGF 36754*; f, *bb 24368*. g, h, *C. laticostatum*: g, *NGF 3284*, from stem; h, *LAE 58797*. i, *C. archipelagi* (*Backer 27827*). j, k, *Calophyllum* sp. 129 (*bb 19445*). l, m, *C. peekelii*: l, *NGF 18330*, from above; m, *BSIP 8804*, from above. n, o, *C. leleanii*: n, *Brass 3447*; o, *Musser et al. S-20a*. p, *C. waliense* (*LAE 59253*). q–t, *C. vexans*: q, *Brass 8337*; r, *LAE 51230*, from below; s, *bb 30923*, from below; t, *NGF 18307*. u, v, *C. papuanum* (*NGF 23956*). w–y, *C. euryphyllum*: w, *NGF 27335*; x, *Hoogland 4662*; y, *LAE 59189*. Scale = 120  $\mu$ m. (in w, scale = 240  $\mu$ m.).



raised, below raised, subangled, the venation obscure above, obscure to subapparent below, 9 to 16 veins/5 mm., angle of divergence 60–75°. Inflorescences from foliate axils, with 5 to 11 flowers; unbranched (rarely with 3-flowered branches to 0.7 cm. long), the axis 0.7–2.8 cm. long, puberulent, lowest internode (0.3–)1–1.7 cm. long; bracts unknown; pedicels 0.8–1.2 cm. long, puberulent. Flower known only in late bud, (?)hermaphroditic; tepals 8, the outer 4 suborbicular, ca. 5.5 by 5.5 mm., farinose-puberulent on back; stamens 200 to 250, the anthers oblong, 1.5–2.3 mm. long, acute at apex; ovary ca. 1 mm. long, the style ca. 1.5 mm. long, the stigma peltate, 1.6–2.4 mm. across, irregularly fringed. Fruit  $\pm$  spherical, 2.4–3.1 by 2.2–2.7 cm., sharply apiculate, drying grayish brown, wrinkled; outer layer detaching  $\pm$  cleanly from stone, 0.5–1.3 mm. thick, compact; stone subspherical, 2.2–2.9 by 2–2.6 cm., rounded at apex, the walls 1.5–2 mm. thick (3–4 mm. thick at base), smooth or slightly rugose, unmarked; spongy layer thin.

DISTRIBUTION. The Solomon Islands (MAP 43).

SPECIMENS SEEN. **Papuasias**. SOLOMON ISLANDS: see Stevens, *loc. cit.*

ECOLOGY. Ridges in primary rainforest, or raised, sometimes flooded, coral platforms; 60 m. alt. Flowering February and March (flower scented); fruiting August and December (fruit green to grayish).

*Calophyllum obscurum* can be recognized by its plump terminal bud and its medium-sized leaf blades that dry dull umber-sepia and have obscure, fairly close venation and a rather indistinct midrib on the upper surface. The inflorescence is covered in grayish, farinose-puberulent indumentum, and the wrinkled fruits have a thin outer layer and a thick-walled stone that appears to lack a basal plug. In two collections the flower is reported to be yellow; this color may be caused by the presumably brownish indumentum covering the white tepals. The specific epithet alludes both to the obscure venation and to the generally undistinguished appearance of the specimens.

The thick-walled stone that lacks a basal plug and the indumentum covering the entire inflorescence immediately distinguish *Calophyllum obscurum* from the other species of *Calophyllum* in the Solomon Islands. It is perhaps related to *C. carrii*, from mainland New Guinea, although that species has more robust twigs, leaf blades with a depressed midrib on the upper surface, clearer venation, and longer pedicels. Ripe fruits of *C. carrii* are unknown. *Calophyllum obscurum* is also similar in many points to *C. costatum*, from Australia; that species, however, has yellowish twigs, smaller leaf blades with less dense venation and a more prominent midrib, and a fruit that, although of similar size, has a thicker outer layer and a stone apparently with a basal plug. The hairs of all these species are rather similar (FIGURES 35, aa, bb, ff–hh; 37, a, b).

127. *Calophyllum* sil Lauterb. Bot. Jahrb. 58: 14. 1922; O. Schwarz, Repert. Sp. Nov. 24: 89. 1927; T. C. Whitmore, Gard. Bull. Singapore 22: 12. 1967; P. F. Stevens, Austral. Jour. Bot. 22: 395. 1974. TYPE: Deutsch

Neu-Guinea [Irian Jaya], Südküste bei Gelieb, 31 Oct. 1907, *Branderhorst 179* (holotype, B, destroyed; isotypes, BO, K, L, U).

*C. ramiflorum* O. Schwarz, Repert. Sp. Nov. **24**: 88. 1927. SYNTYPES: Australia [Northern Territory], Port Darwin, cliffs near Hospital, *Bleeser 502* (NSW, MEL); Finniso River District, *Bleeser A27* (n.v.).

*C. procerum* A. C. Smith, Jour. Arnold Arb. **22**: 344. 1941. TYPE: Papua, Middle Fly River, Lake Daviumbu, Aug. 1936, *Brass 7589* (holotype, A; isotypes, BRI, L).

*Calophyllum* sp. Lauterb. Nova Guinea Bot. **8**: 309. 1910.

*C. warburgii* auct., non Engler; A. C. Smith, Jour. Arnold Arb. **22**: 345. 1941, *quoad Brass 7724*.

Tree 4–30 meters tall, d.b.h. to 139 cm.; trunk without buttresses (with spurs); outer bark yellowish at first, becoming rusty brown to gray,  $\pm$  deeply fissured, with transverse cracks between fissures, scaling or not; under bark bright red; latex yellow or greenish yellow, clear, sticky, sometimes aromatic.

Twigs slightly flattened, 2.6–4 mm. across, strongly 4-angled (rounded or with 6 raised lines), drying brown, sparsely brown-farinoso; axillary innovations lacking basal scars; internodes 0.3–3.5 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, spreading, inconspicuous; terminal bud plump, 5–10(–13) mm. long, with brown, puberulent indumentum (hairs, FIGURE 37, c–f), underdeveloped internode to 2.5(–3.5) mm. long. Petiole 0.6–1.5(–2) cm. long, broadly concave above, convex below, glabrous when mature; lamina obovate to elliptic (suboblong), (2.8–)5–12.5 by (1–)2.5–5.5 cm., acute to cuneate or rounded at apex, cuneate, acute, or broadly rounded and ultimately shortly acute at base, broadly undulate but slightly (rarely strongly and broadly) recurved at margin, coriaceous, drying  $\pm$  cinnamon-sepia on both surfaces or greenish olivaceous to fuscous-black above and olivaceous below, glabrous or sparsely farinose-puberulent on midrib below (also above when young), the midrib above gradually narrowed from base, depressed, 0.25–0.6 mm. wide at midpoint, becoming raised in upper  $\frac{1}{6}$ – $\frac{1}{4}$ (– $\frac{2}{3}$ ) of lamina, below raised, striate to obscurely angled, the venation above and below apparent, raised, on lower surface often with latex canals ascending obliquely over veins, (5 to) 7 to 13 veins/5 mm., angle of divergence (60–)70–80°. Inflorescences from usually foliate axils along stem, with 3 to 13 flowers, usually unbranched (very rarely with 3-flowered branches to 5 mm. long), the axis 0.3–4.5 cm. long, farinose-puberulent, lowest internode (0.1–)0.2–0.7(–1.2) cm. long; bracts ovate, to 3.5 mm. long, densely puberulent below, deciduous; pedicels 3–7 mm. long, farinose-puberulent. Flower (?) hermaphroditic; tepals 4 (to 6), the outer two ovate, 3.5–4 by 2.5–3 mm., sparsely farinose on back, the inner ones elliptic to obovate, 4.5–6 by 2.5–4 mm.; stamens 45 to 80, the filaments to 2.5 mm. long, the anthers oblong, 0.5–1.3 mm. long,  $\pm$  retuse at apex; ovary 1.3–1.5 mm. long, the style 1.5–1.7 mm. long, the stigma peltate, 0.5–0.7 mm. across, slightly radiate. Fruit spherical to ovoid, 1.3–1.9 by 1–1.6 cm.,  $\pm$  acute at apex, drying vinaceous-brown, sharply wrinkled; outer layer not detaching cleanly from stone, 0.4–1.2 mm. thick, to 2 mm. thick toward apex, compact; stone  $\pm$  spherical, 0.8–1.3

by 0.8–1.2 cm., rounded at apex, the walls 0.15–0.4 mm. across, smooth, (?)unmarked; spongy layer thin.

DISTRIBUTION. Southern mainland New Guinea and northern Australia; forms of uncertain status from the Moluccas, northern mainland New Guinea, and New Britain (Map 40).

SELECTED SPECIMENS SEEN. **Moluccas.** HALMAHERA: Tobelo, N. Totodokoe, 30 m., *bb* 33807 (?) (BO, L, SING); Weda, Tilope, 25 m., *bb* 24843 (?) (BO, L, SING). SERAM: Kiandarat, 60 m., *bb* 25830(?) (BO, L, SING). TANIMBAR: Otimmer, 100 m., *bb* 24368 (?) (BO, L, SING). **Papuasias:** see Stevens, *loc. cit.* Also, IRIAN JAYA. Vogelkop: Beriat ( $\pm$  12 km. S. of Tenimaboean), 10 m., *BW* 6259 (?) (L). PAPUA NEW GUINEA. Madang: Imbron R., 30 m., *NGF* 49237 (?) (A, L, LAE). Western: 2 km. W. of Iokwa, 10 m., *LAE* 60448 (L). **Australia.** WESTERN AUSTRALIA: Mitchell Plateau, N. Kimberley, *Beard* 7013 (DNA, NSW, PERTH); Prince Regent R. Reserve, Gariyeli Creek, Fern Gulley, *George* 12822 (PERTH); Bonaparte Archipelago, Osborn Is., *P. G. Wilson* 11061 (PERTH). NORTHERN TERRITORY: Cannon Hill, *Must* 791 (CANB, DNA, K, LAE); W. face of Mt. Brockman Range, 30 m., *Schodde* AE2 (CANB, DNA, K); Bay no. 3 [Arnhem Bay] is., *R. Brown* "6302" (BM, K); Sampit Creek Gorge, Arnhem Land, *McKean* B796 (CANB); 65 km. NE. Pine Creek, W. Arnhem Land, *Balgooy & Byrnes* 1348 (DNA, K, L, LAE); 3 km. S. of E. Alligator R. crossing, *Byrnes* 2187 (CANB, DNA, LAE); Jim Jim Falls area, *R. E. Fox* 521 (DNA); Caledon Bay, *Byrnes* 973 (DNA); Lee Point, *Byrnes* 1734 (DNA); Gulmarri, Elcho Is., *Dunlop* 3949 (DNA); Giddy R. crossing, *Byrnes* 2592 (DNA, CANB); Port Darwin, *Holtze* 38 (MEL). QUEENSLAND: Jardine R., *Gittins* 1844 (NSW); Iron Range, 20 m., *Brass* 19294 (A, CANB, K, SING); W. of Bamaga, ca. 2.7 km. SW. of Cape York, *L. S. Smith* 12485 (A, CANB, K, L, LAE); Scrubby Creek, 9½ km. N. of Rocky R., 50 m., *Hyland* 5433 (L); Claudie R., 80 m., *Dockrill* 564 (K, L); Arbor. Res. 1, between McIvor R. and Cape Flattery, 20 m., *Hyland* 6552 (K, L); Cook Distr., Annam R. junction with Parrot Creek, 215 m., *L. S. Smith* 14321 (A, CANB, L, LAE, MEL); Weipa Concession, Marmoss Creek, 10 m., *Dockrill* 859 (LAE); Granite Creek, Lower Bloomfield R., *L. S. Smith* 11086 (L); Etty Bay, Innisfail, *L. S. Smith & Webb* 3265 (A); Trinity Harbour, *W. Hill* 54 (MEL).

ECOLOGY. Savanna woodland or riverine gallery forest (see also Beard, 1976, as *C. australianum*), rarely secondary forest; 7–215 m. alt. Flowering April, and June to August (flower scented); fruiting May, and September to November (fruit bluish to purple-black).

*Pajmans* 376 and *L. S. Smith* 11086 have galls on the leaf; these are slightly transversely elongated pustules at right angles to, and often near, the midrib.

The variant grows in rainforest, 10–630 m. alt.

LOCAL USE. The wood is used for larger dugout canoes on the Fly River (Western Province, Papua New Guinea).

*Calophyllum sil* can be recognized by its plump terminal bud; its moderate-sized and more or less elliptic lamina that has a depressed midrib on the upper surface and that dries more or less concolorous; its four-tepaled flowers; and its fruits, which dry sharply wrinkled and vinaceous-brown, with the



outer layer moderately developed, compact, and not detaching from the thin-walled stone. The specific epithet, *sil*, is a name given to this species in the southern part of Irian Jaya.

Variation within *Calophyllum sil* is discussed in Stevens (*loc. cit.*). The specimens from New Guinea cited above with a question mark belong to the variant that usually grows at a moderate elevation (but *BW* 6259 was collected at 10 m. alt.) in rainforest; the status of this variant is unclear, since all except one of the specimens (*NGF* 36754) are sterile. The specimens cited above from the Moluccas region are also all sterile. Some (e.g., *bb* 33807) have rather thickly coriaceous leaf blades with broadly recurved margins, and the older leaves tend to dry fuscous-black on the upper surface.

*Calophyllum sil* is probably related to *C. laticostatum* and perhaps also to *C. collinum*. All have basically similar hairs (FIGURES 35, x, y, cc-ee; 37, c-h), blue fruits, and flowers often with four tepals (flowers of *C. collinum* are not known). In addition, both *C. sil* and *C. laticostatum* sometimes have latex canals on the lower surface of the leaf obliquely ascending over the normal latex canal/vein system. *Calophyllum sil* is not close to *C. australianum* (= *C. calaba* var. *australianum*), as was suggested earlier (Stevens, *loc. cit.*). Although young plants of *C. sil* have leaves similar in shape to those of *C. calaba* var. *australianum*, the twigs of the former are almost square in transverse section, while those of the latter are flattened; the hairs of the two are not notably similar (cf. FIGURES 37, c-f, and 12, q).

128. *Calophyllum laticostatum* P. F. Stevens, Austral. Jour. Bot. **22**: 375, fig. 8. 1974. TYPE: Papua, Milne Bay, about 6 miles [8 km.] up the Dawa Dawa River, 250 feet [75 m.], March 1945, *NGF* 1327 coll. L. S. Smith (holotype, LAE; isotypes, A, BRI, CANB, L, NSW).

Tree 15–43 meters tall, d.b.h. to 91 cm.; trunk without buttresses or spurs (?rarely with aerial roots); outer bark yellowish in young tree, becoming gray to brown, shallowly to rather deeply fissured, scaling or not, the inner surface dark red, or orange-brown and orange or red and brown mottled; under bark dark red; inner bark dark red; latex yellow (greenish yellow), clear, sticky.

Twigs slightly flattened, 2–5.5 mm. across, 4-angled, drying deep brown, subpersistently brown farinose-puberulent; axillary innovations lacking basal scars; internodes (0.4–)1–3 cm. long; uppermost pair of axillary buds rounded, to 2 mm. long, spreading, inconspicuous; terminal bud plump, (0.8–)1.3–2.7 cm. long, with  $\pm$  crustaceous, gray-brown indumentum (hairs, FIGURE 37, g, h), underdeveloped internode to 4 mm. long. Petiole (0.4–)0.7–1.4 cm. long, broadly concave above, glabrescent below; lamina elliptic to narrowly obovate, (3–)6.5–16 by (0.8–)1.4–4.5 cm., acute (rarely acuminate (*NGF* 18373)) at apex, narrowly cuneate at base, very base often shortly rounded, not undulate to rather distantly so and narrowly to broadly recurved at margin, coriaceous, drying  $\pm$  umber above and sabelline-sepia below, transiently farinose on midrib (rarely near margin) below, or glabrous, the midrib above narrowed gradually from base, broadly depressed, 0.2–1.6 mm. wide at

midpoint, below raised, striate, the venation above obscure to subapparent, below  $\pm$  apparent, raised, sometimes with latex canals ascending over veins on lower surface, (9 to) 11 to 20 veins/5 mm., angle of divergence (40–)60–70 (–80)°. Inflorescences from foliate axils along twigs, with 5 to 21 flowers, unbranched (rarely with 3-flowered branches to 3 mm. long), the axis 1.2–5.5 cm. long,  $\pm$  puberulent, especially toward base, lowest internode 3–11 mm. long; bracts ovate, ca. 4 mm. long, deciduous; pedicels 2–11 mm. long, sparsely puberulent to glabrous. Flower known only from buds, (?)hermaphroditic; tepals 4 or 6, the outer pair ovate, ca. 5 by 4 mm.; stamens ca. 168, the anthers oblong, ca. 1 mm. long,  $\pm$  retuse at apex; ovary ca. 1 mm. long, the style ca. 1.2 mm. long, the stigma excentrically peltate, ca. 0.8 mm. across. Fruit ovoid to subspherical, 1.3–1.9 by 1.2–1.6 cm., rounded at apex, drying mid-brown, broadly and obscurely wrinkled; outer layer not detaching cleanly from stone, (0.5–)1–3 mm. thick, compact or with air spaces developing under skin; stone subspherical, 0.65–1.1 by 0.6–1 cm., rounded at apex, the walls 0.2–0.8 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Western New Guinea (MAP 39), possibly the Philippine Islands (Luzon).

SELECTED SPECIMENS SEEN. **Philippine Islands.** LUZON. Mt. Calvario, Dolores, 600 m., *FB 30019* (UC). **Papuaia:** see Stevens, *loc. cit.*

ECOLOGY. Well-drained lowland or colline rainforest, 20–1370 m. alt. Flowering in January; fruiting October, January, and March, submature fruit in May (fruit bluish).

YOUNG PLANT. The young plant is erect, and the terminal bud is functional.

*Calophyllum laticostatum* can be recognized by its fairly long (usually more than 1 cm.), plump terminal bud and its rather narrowly elliptic, coriaceous leaf blades that have a broadly sunken midrib narrowing gradually from the base. The fruits are small (less than 2 cm. long) and have a well-developed outer layer. The epithet *laticostatum* (“broad midrib”) emphasizes one of the most prominent features of the species.

*Calophyllum laticostatum* is apparently related to *C. archipelagi* and *Calophyllum* sp. 129. The three taxa can be separated as shown in TABLE 15. Stevens (*loc. cit.*) compared *C. laticostatum* with the New Caledonian species *C. caledonicum* and *C. montanum* (= *C. caledonicum*). *Calophyllum caledonicum* is perhaps most closely related to the *C. vitiense*–*C. neo-ebudicum* complex and has larger fruits and flowers with eight or more tepals.

Relatively little material of *Calophyllum laticostatum* in flower and fruit is known, and there is a considerable amount of vegetative variation (see also Stevens, *loc. cit.*). The single specimen cited from the Philippine Islands (*FB 30019*) has a small terminal bud (figures in parentheses in the description above) and rather small leaves, and its pedicels are ca. 1 cm. long (usually less than 7 mm. in other specimens). However, when compared with the Papuan specimens, it agrees well in other vegetative characters, and its submature fruits seem to be of the same general type—albeit with a slightly thinner outer layer.

TABLE 15. Comparison of differences between *C. laticostatum*, *Calophyllum* sp. 129, and *C. archipelagi*.

	<i>C. laticostatum</i>	<i>Calophyllum</i> sp. 129	<i>C. archipelagi</i>
TERMINAL BUD LENGTH (mm.)	(8-)13-27	9-13	6-7.5
TWIG THICKNESS (mm.)	2-5.5	1.5-3	(1.3-)2-3(-3.5)
LEAF			
PETIOLE WIDTH (mm.)	(1.2-)2-3.5	1-2(-2.5)	1-2
LAMINA TEXTURE	Very coriaceous	Coriaceous	Coriaceous
VENATION DENSITY (veins/5 mm.)	(9 to) 11 to 20	6 to 11	(4 or) 5 to 9
LOWEST INTERNODE OF INFLORESCENCE, LENGTH (mm.)	3-11	12-18	8-15
TEPAL NUMBER	4 to 6	Unknown	8
PEDICEL LENGTH (mm.)	2-8(-11)	7-13	5-16
FRUIT			
LENGTH (cm.)	1.3-1.9	Ca. 1.4	Ca. 3
OUTER LAYER THICKNESS (mm.)	(0.5-)1-3	< 1	Ca. 0.5
AIR SPACES DEVELOPING IN OUTER LAYER	Under skin	Throughout	± Throughout

NGF 18373, from Kiunga, Western Province, Papua New Guinea, has leaf blades that are acuminate at the apex. Field notes of this specimen mention "much branched aerial roots." I have not seen such roots on plants of *Calophyllum laticostatum* either at Kiunga or on New Britain.

129. *Calophyllum* sp.

FIGURE 36, a.

*C. celebicum* Koord. (*quoad* Koorders 17305) et *C. wawaroenti* Koord. in Koord.-Schum. Syst. Verzeich. (Fl. N.O. Celebes) 3: 87. 1914. *Nomina*.

Tree to 31 meters tall, d.b.h. to 55 cm.; trunk and bark unknown; latex yellow, pale yellow, or greenish.

Twigs slightly flattened, 1.5–3 mm. across, 4-angled, drying mid- to darkish-brown, brown farinose-puberulent when young, axillary innovations lacking basal scars; internodes 0.7–3 cm. long; uppermost pair of axillary buds rounded, ca. 0.5 mm. long, spreading, very inconspicuous; terminal bud plump, 0.9–1.3 cm. long, with subcrustose, grayish brown indumentum (hairs, FIGURE 37, j, k), underdeveloped internode to 1(–5) mm. long. Petiole 1.3–1.8 cm. long, broadly concave above, convex below, glabrous; lamina elliptic to subobovate, 9–20 by 2–4.8 cm., acute to subacuminate at apex, narrowly cuneate to subacute at base, rather strongly and closely undulate but not recurved at margin, thinly coriaceous, drying umber to sabelline-olivaceous above and umber to sabelline below, glabrous when mature, the midrib above narrowed gradually from base, broadly depressed, 0.35–0.6(–1) mm. wide at midpoint, below raised, subangled to striate, the venation usually apparent on both surfaces, raised, 6 to 11 veins/5 mm., angle of divergence 65–75(–80)°. Infructescences from foliate axils, with scars of 11 to 15 flowers, unbranched, the axis to 5.5 cm. long, sparsely puberulent toward base, lowest internode 1.2–1.8 cm. long; bracts unknown; pedicels 0.7–1.3 cm. long, glabrous. Flower unknown. Fruit subspherical, ca. 1.4 by 1.4 cm., rounded at apex, drying vinaceous-brown, smooth; outer layer not detaching cleanly from stone, (?)thin, completely disorganized by large air spaces; stone ellipsoid, ca. 1.2 by 1 cm., minutely apiculate, the walls ca. 0.5 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Celebes, Moluccas (Soela Island), Poeloe Laut off southeastern Borneo (MAP 39).

SPECIMENS SEEN. **Borneo.** **KALIMANTAN.** Selatan: Poeloe Laut, Sei Paring, 100 m., *bb* 13248 (BO). **Celebes.** **SULAWESI:** Minahassa, Menado, bij Bivak Totok, Ratatotok, 200 m., *Koorders* 17305 (BO, L), bij Kajoewatoe, 200 m., *Koorders* 17293 (BO, L), Gorontalo, Poso, 100 m., *bb* 19445 (A, BO, L, SING). **SALAJAR:** Ond. Saleier, Lembang2, cil. Djampia, 245 m., *bb* 22947 (L). **Moluccas.** **MANGOLE:** Kimakol, Lampaoe, 30 m., *bb* 29806 (A, BO, L, SING).

ECOLOGY. (?)Forest, 30–200 m. alt. Fruiting January (almost ripe); fruit blue.

*Calophyllum* sp. 129 can be recognized by its only slightly flattened twigs; its large, plump terminal buds; and its rather thinly coriaceous, usually elliptic

lamina. The midrib on the upper surface of the lamina is broadly depressed and narrows gradually from the base. The pedicels are relatively long and slender, and the fruits are subspherical, with the outer layer probably thin and completely disorganized by air spaces.

*Calophyllum* sp. 129 is closely related to *C. laticostatum* and *C. archipelagi*, but can be separated from them by the differences given in TABLE 15.

130. *Calophyllum archipelagi* P. F. Stevens, sp. nov.

FIGURE 33, d.

A speciebus aliis Calophylli in costa in pagina superiore laminae depressa, lamina tenuiter coriacea, axe inflorescentiae 2.5–6.5 cm. longo, tenui, et fructu submagno circa 3 mm. longa, differt.

Tree 10–30 meters tall, d.b.h. to 55 cm.; outer bark dark brown, rough; inner bark red-brown.

Twigs flattened, (1.3–)2–3(–3.5) mm. across,  $\pm$  strongly 4-angled, drying blackish to brown, brown-farinaceous when young; axillary innovations lacking basal scars; internodes (0.5–)1–5 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, suberect, inconspicuous; terminal bud plump to conical, 6–7.5 mm. long, with grayish to ferruginous, subcrustaceous indumentum (hairs, FIGURE 37, i), underdeveloped internode to 1(–6) mm. long. Petioles 0.7–1.6 cm. long, broadly concave above, convex below, farinose when young; lamina elliptic, 4.6–15 by 2.3–5.1 cm.,  $\pm$  acute at apex, acute to narrowly cuneate at base, strongly but distantly undulate and slightly recurved at margin, coriaceous, drying sepia to olivaceous above and cinnamon to sepia below, very transiently sparsely farinose on midrib below, the midrib above gradually narrowed from base, depressed, 0.35–0.7 mm. wide at midpoint, below raised, angled toward apex and striate toward base, the venation apparent on both surfaces, raised, (4 or) 5 to 9 veins/5 mm., angle of divergence 65–75(–80)°. Inflorescences from foliate axils along twigs, with 9 to 17 flowers, usually not branched (rarely with 3-flowered branches to 1 cm. long), lowest flowers sometimes flabellately arranged, the axis 2.5–6.5 cm. long, sparsely farinose, lowest internode 0.8–1.5 cm. long; bracts not known; pedicels 0.5–1.6 cm. long, sparsely farinose. Flower known only in bud, (?)hermaphroditic; tepals 8, the outer pair broadly ovate, ca. 5 by 4.5 mm., the inner ones  $\pm$  glabrous; stamens 180 to 190, the anthers oblong, 1.3–2.2 cm. long, retuse at apex; ovary ca. 1.5 mm. long, the style ca. 2.7 mm. long, the stigma peltate, ca. 1 mm. across. Fruit ellipsoid to ovoid, ca. 3 by 2 cm., rounded at apex, drying brown to vinaceous, smooth to broadly and irregularly wrinkled; outer layer not detaching cleanly from stone, ca. 0.6 mm. thick, with large air spaces developing; stone ellipsoid, 2.1–2.4 by 1.2–1.8 mm., rounded at apex, the walls 0.6–0.9 mm. thick, smooth, unmarked; spongy layer (?)thin.

TYPE: Java, Kangean, G. Eteng bij Tambajangan, 30 March 1919, *Backer* 27827 (holotype, BO; isotypes, A, BO (several), L).

DISTRIBUTION. Kangean Island off northeastern Java, the Lesser Sunda Islands (MAP 39).

ADDITIONAL SPECIMENS SEEN. **Java and adjacent islands.** TIMUR: Kangean Is., G. Eteng, Tambajangan, *Backer* 27596 (BO). **Lesser Sunda Islands.** SUMBAWA: Mangkar Moenteh, 70 m., *bb* 14016 (BO), 350 m., *bb* 11477 (BO). KOMODO: sine loco, *Saakov* 39 (BO). FLORES: Maomere, Managadjoeng, 500 m., *bb* 9654 (BO); W. part, near Reo, *Kostermans & Wirawan* 921 (AAU, G, L); Nunang, See, 650 m., *Schmutz* 775 (L).

**ECOLOGY.** Hilly ground (sometimes limestone) or ground flooded during rainy season, 70–650 m. alt. Flowering (almost open buds) April and May; submature fruit August and October.

*Calophyllum archipelagi* can be recognized by its elliptic leaves with a broadly depressed midrib on the upper surface, its relatively short (less than 8 mm.), plump terminal buds, and its rather large (ca. 3 cm.) fruits with thin outer and woody layers. The specific epithet alludes to the fact that all the specimens of this taxon have been collected from the Sunda Archipelago.

*Calophyllum archipelagi* is perhaps related to *C. laticostatum* (from Papuaia) and *Calophyllum* sp. 129 (mostly from the Celebes and Moluccas). Both of the latter taxa have less flattened young twigs and older twigs that dry striate (vs. more or less terete as in *C. archipelagi*). Other differences between these taxa are given in TABLE 15.

Two specimens of *Calophyllum archipelagi* have fruits. The fruits of *Saakov* 39 dried vinaceous, and the lamina margin dried much paler than the rest of the leaf; *bb* 9654 has fruits that dried brown, although they are identical in structure to those of *Saakov* 39, and the lamina margin did not dry paler than the rest of the leaf. In this latter character *bb* 9654 is like the other specimens cited above.

*Schmutz* 775 is a sterile specimen, perhaps collected from a sapling. The midrib is narrowly depressed only at the base of the lamina.

131. *Calophyllum peekelii* Lauterb. Bot. Jahrb. 58: 11. 1922; P. F. Stevens, Austral. Jour. Bot. 22: 386. 1974. SYNTYPES: Neu-Mecklenburg [New Ireland], Namatanai, Jan. 1909, *Peekel* 781, Namarodu, Jan. 1909, *Peekel* 132; Key Inseln, Pulu Ubur, *Warburg* 20041 (all B, destroyed).

FIGURE 6, h, i.

*C. kajewskii* A. C. Smith, Jour. Arnold Arb. 22: 353. 1941; F. S. Walker, Forests Brit. Solomon Is. Prot. 123. 1948; T. C. Whitmore, Guide Forests Brit. Solomon Is. 77. 1966, Gard. Bull. Singapore 22: 9. 1967; Foreman, Check List Vasc. Pl. Bougainville, 42, 84. fig. 1974. TYPE: Bougainville, Buin, Koniguru, 800 m., 6 Aug. 1930, *Kajewski* 2024 (holotype, A; isotypes, BO, BRI, C, G, L, NSW, P, SING).

Tree 20–40(–63) meters tall, d.b.h. to 180 cm.; trunk sometimes with small, thick buttresses or spurs to 1.6 meters tall; outer bark dark brown, deeply fissured, scaling, thick, the inner surface blackish, or brownish black and yellow mottled; under bark pink-brown to deep red; inner bark pink-brown to deep red; latex clear (opaque) yellow, very sticky. Crown broad, branches spreading, leaves suberect.

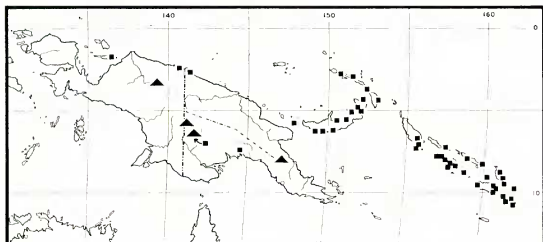
Twigs not to somewhat flattened, 3.8–6.5 mm. across, strongly 4-angled to alate (rarely obscurely angled), drying dark brown, glabrous or sparsely transiently farinose when young; axillary innovations lacking basal scars; internodes (0.5–)1–7 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, spreading, inconspicuous; terminal bud plump, 0.9–1.5 cm. long, with crustaceous, grayish brown indumentum (hairs, FIGURE 37, 1, m), underdeveloped internode 2–5 mm. long. Petiole 1.1–2 cm. long, broadly concave above, convex to subangled below, glabrous when mature; lamina obovate to oblong or subelliptic, 8.5–17.5(–21.5) by 3.5–10 cm., rounded to shallowly retuse at apex, acute at base, distantly undulate and not recurved to slightly so at margin, rather thickly coriaceous, drying sepia to vinaceous-buff above and sepia to sabelline below, sparsely farinose on midrib when young, soon glabrescent, the midrib above narrowing rather gradually from base, slightly raised, center  $\pm$  sulcate, below raised, angled to striate, the venation apparent above and below, raised, 6 to 9 (to 12) veins/5 mm., angle of divergence 65–75°. Inflorescences from foliate axils, with 7 to 21 (to 31) flowers (with 5-flowered branches to 1.7 cm. long), the axis 1.5–8 cm. long, glabrous (rarely farinose toward base), basal internode (0.1–)0.4–1.1(–2) cm. long; bracts ovate, to 4 mm. long, soon deciduous; pedicels 0.7–1.5(–2) cm. long, glabrous. Plants (?)dioecious; tepals 8, sometimes glabrous, the outer pair broadly ovate, 4–5 by 3.5–5.5 mm., the inner ones elliptic to obovate, 4.5–7.3 by 6–6.3 cm.; stamens 210 to 290, in staminate flower the filaments to 6 mm. long, the anthers oblong, 1.7–2.5 mm. long, apiculate, in pistillate flower filaments to 2 mm. long, anthers 1–1.5 mm. long; ovary ca. 2.5 mm. long, the style 2.7–3.5 mm. long, the stigma peltate, in pistillate flower ca. 4 mm., or in staminate flower ca. 2 mm. across, irregularly dentate at edge. Fruit spherical to ovoid, 4.5–7 by 4.2–6 cm., rounded to obtusely pointed at apex, drying brownish, with broad, shallow, longitudinal wrinkles; outer layer detaching cleanly from stone, 2–4 mm. across, compact; stone spherical to  $\pm$  ovoid-ellipsoid, 3.8–6 by 3.7–5.2 cm., rounded to obtusely pointed at apex, the walls 3–5 mm. thick, smooth, unmarked, basal plug to 7 mm. across; spongy layer thin.

DISTRIBUTION. Japen Island; scattered on mainland New Guinea; New Britain and New Ireland to the Solomon Islands (MAP 41).

SELECTED SPECIMENS SEEN. **Papuasias:** see Stevens, *loc. cit.* Also, PAPUA NEW GUINEA. Gulf: Aird [Kikori] R., [T. F.] Bevan *s.n.*, MEL 75535 (fruit only) (MEL).

ECOLOGY. Usually in well-drained primary lowland rainforest, also in seasonally inundated rainforest, swamps, forest growing over limestone; to 311 m. alt. Flowering (or late bud) February, April, August, September, and December (flower scented); fruiting January, February, June, September, and November (fruit dull green or blue-green (NGF 18330), perhaps eaten by flying foxes (LAE 66044)).

Details of regeneration of *Calophyllum peekelii* on Kolombangara (the Solomon Islands) are given by Whitmore (1974, as *C. kajewskii*): dispersal



MAP 41. Distribution of *Calophyllum peekelii* (squares) and *C. collinum* (triangles) in Papuaia.

of the seed is poor (the fruits are reported to be blue-black—see above), and development of trees from seedlings takes place in high forest or in gaps. The growth rate of the tree seems to increase with size (Whitmore, 1974, fig. 7.2).

There are small, crateriform galls on the upper surface of the leaf, mostly near the midrib, in NGF 39344.

**GERMINATION AND YOUNG PLANT.** The radicle pushes out the basal plug from the stone during germination. The seedling has three pairs of leaves separated by well-developed internodes; the lowest pair is only ca. 1 cm. long and soon drops off. Subsequently produced internodes are also well developed, growth is erect, and the terminal bud is functional. (NGF 12352; Stevens, LAE sheet no. 125333.)

**LOCAL NAMES AND USES.** “Baula,” “bau’ula” (Kwara’ae, Solomon Islands). The wood is strong and is excellent for building canoes or houses. The bark can be removed from the log, dried, and used as a fuel; the flammable latex in the bark ensures a good blaze.

*Calophyllum peekelii* is a very distinctive species with its stout, strongly four-angled twigs, its obovate to oblong, coriaceous leaf blades that are rounded to retuse at the apex, and its large fruits the size of a small orange. The fruits have a thick-walled stone with a basal plug that is pushed out during germination. The specific epithet commemorates the missionary G. Peekel, who lived in New Guinea for over forty years.

There is little variation within *Calophyllum peekelii*, but as with the other possibly dioecious taxa, more material and field observations are needed to determine whether or not the species is dioecious or has some other breeding system.

Saplings of *Calophyllum peekelii* have leaves with blades up to 42 by 14 cm. that are rather abruptly acuminate at the apex.



The only record of *Calophyllum peekelii* from the Gulf Province of Papua New Guinea is based on detached fruits. However, as noted above, these are very distinctive.

A neotype of *Calophyllum peekelii* is not selected since it is not clear that all of the syntypes have been destroyed. The correct application of the name *C. peekelii* is discussed in Stevens (*loc. cit.*).

132. *Calophyllum leleanii* P. F. Stevens, sp. nov.

FIGURE 40, e-g.

- C. solomonense* A. C. Smith, Jour. Arnold Arb. 22: 346. 1941, *typo excepto*;  
T. C. Whitmore, Guide Forests Brit. Solomon Is. 78. 1966, *pro parte*,  
Gard. Bull. Singapore 22: 9. 1967, *pro parte*; P. F. Stevens, Austral.  
Jour. Bot. 22: 398. 1974, *pro parte*.  
*C. grandifolium* Koord. ex Koord.-Schum. Syst. Verzeich. (Fl. N. O.  
Celebes) 3: 87. 1914. *Nomen*.

A speciebus aliis *Calophylli* in gemma terminali aliquanto longo, lamina plerumque 10–28 cm. longo et 4.5–10 cm. lato, nervis lateralibus manifestis, et fructu strato exteriore 0.6–2 mm. crasso, putamine parietibus 1.3–2 mm. crassis et obturamento circa 10 mm. in transverso proviso, differt.

Tree 8–25 meters tall, d.b.h. to 54 cm.; trunk without buttresses; outer bark orange to yellowish when young, becoming brown to gray, scaly, the inner surface yellow to orange; under bark red; inner bark red; latex yellow, clear or opaque.

Twigs flattened, (3–)4–6 mm. across, slightly 2-, 4-, or 6-angled, with obscure horizontal lines at nodes, drying brown, farinose-puberulent when young; axillary innovations lacking basal scars; internodes (0.7–)1.5–10 cm. long; uppermost pair of axillary buds subacute, 1–6 mm. long, spreading to suberect; terminal bud often narrowly conical, 0.8–2 cm. long, with brown, crustaceous to adpressed indumentum (hairs, FIGURE 37, n, o; cf. 37, d), underdeveloped internode to 4.5 mm. long. Petiole 1.1–2.5 cm. long, concave above and convex to angled below, puberulent when young; lamina elliptic or ovate to suboblong, (5.5–)10–28 by (2.5–)4.5–10 cm., obtuse to short-acuminate at apex, acute to cuneate at base, narrowly recurved and undulate at margin, coriaceous, drying umber to grayish sepia above and fulvous to olivaceous below, sparsely puberulent on midrib below when young, the midrib above abruptly narrowed at to gradually narrowed from base,  $\pm$  raised, center sulcate, 0.2–0.9 mm. wide at midpoint, below strongly raised, angled, the venation apparent on both surfaces, especially so above, raised, latex canals sometimes raised, 5 to 10 veins/5 mm., angle of divergence 50–80°. Inflorescences from foliate axils near ends of twigs, with 5 to 11 flowers (with 3-flowered branches to 3 mm. long), the axis 0.3–2.5 cm. long, subglabrous, lowest internode 1–10 mm. long; bracts not known; pedicels 0.8–1.7 cm. long, glabrous. Flower staminate or hermaphroditic; tepals 4, 7, or 8, glabrous or almost so, the outer pair suborbicular, 6–7.5 by 5.5–8 mm., fleshy, strongly concave, the next pair suborbicular, ca. 7 by 6 mm., the inner ones spatulate-lingulate, 8.5–11 by 3–4.2 mm.; stamens 330 to 420, the filaments to 7 mm.

long, the anthers elliptic-oblong, 0.8–1.5 mm. long, retuse at apex; ovary in hermaphroditic flower ca. 2 mm. long, in staminate flower absent, the style ca. 2.7 mm. long, the stigma peltate, ca. 0.9 mm. across. Fruit subspherical, 1.8–3.5 by 1.6–3.1 cm.,  $\pm$  apiculate, drying grayish brown, wrinkled; outer layer not detaching cleanly from stone, 0.6–2 mm. thick, to 4 mm. thick when fresh, compact; stone spherical to ellipsoid, 1.6–2.5 by 1.4–1.9 cm., rounded to obscurely apiculate at apex, the walls 1.3–2 mm. thick, to 3 mm. thick at base, smooth, unmarked, basal plug ca. 10 mm. across; spongy layer thin.

TYPE: Papua New Guinea, West New Britain District, Hoskins Sub-District, Mt. Lollo, 1260 feet (386 m.), 13 Feb. 1971, LAE 51145 coll. *Lelean & Stevens* (holotype, A; isotypes, K, L, LAE).

DISTRIBUTION. Scattered: Sulawesi (probable), New Britain, and the Solomon Islands (MAP 40).

ADDITIONAL SPECIMENS SEEN. **Celebes.** SULAWESI: Minahassa, *Koorders* 17291 (BO, LL, P), 17298 (BO, K, L, P); Sungei Sadaunta, *Musser et al.* S-20a (A). **Papuasias.** PAPUA NEW GUINEA. New Britain: Kandrian Subdistr., Fullerborn village, 60 m., NGF 21788 (A, CANB, L, LAE); road W. of Fullerborn Harbour, about 1 mile, 100 m., NGF 12957 (L); near Kandrian, *Stevens s.n.*, LAE sheet no. 140450 (LAE); Mt. Lollo, NGF 6607 (A, BO, CANB, K, L, LAE), 30510 (LAE). SOLOMON ISLANDS. Guadalcanal: Makina area, Marau, 270 m., BSIP 9458 (K, L); Rere R., BSIP 2794 (K, L), 3317 (L); Sandfly Is., Florida, 45 m., BSIP 18090 (SING). Santa Isabel: Tataba, 50 m., Brass 3447 (A, BRI, L);  $\frac{1}{2}$  mile due W. of Tatamba, BSIP 2580 (K, L); Nahao Bay, 51 m., BSIP 7308 (K, L).

ECOLOGY. Locally common in primary slope and ridge forest; on Santa Isabel on soil derived from ultramafic rock; 45–914 m. alt. Flowering in December; fruiting December and April (fruit greenish).

LOCAL USES. The wood is used for making spears, and a dye is made from the plant (West Nakanai, Hoskins); it is a good timber tree.

*Calophyllum leleanii* can be recognized by its fairly long terminal bud and suberect to spreading uppermost axillary buds; its rather large lamina with the midrib on the upper surface often relatively inconspicuous; its large flowers, which have numerous stamens (more material is needed to confirm this); and its sharply and shallowly wrinkled fruits. The fruits have a fairly thick outer layer and stone wall; the stone has a basal plug. It is a pleasure to name this taxon after Mr. Y. Lelean, who has accompanied me on many field trips in Papua New Guinea.

*Calophyllum leleanii* seems most closely related to *C. waliense*; this is discussed further under *C. waliense*.

The specimens of *Calophyllum leleanii* from Sulawesi are included with some hesitation. They are all sterile, but in all details including hair structure (FIGURE 37, n, o) they agree with specimens from New Britain and the Solomons. However, more collections of *C. leleanii* are needed, both to confirm its range and to establish the distribution of staminate and hermaphroditic flowers

in the population (see also Stevens, *loc. cit.*, as *C. solomonense*).

The type specimen of *Calophyllum solomonense* has long seemed to me rather different from the other specimens that were included in the species: the terminal bud has tomentose indumentum, with the hairs long and often branched at the base (cf. FIGURES 37, n, o, and 14, a-m), and the pedicels of the submature fruits are rather long and slender. In both these and other characters the type agrees with *C. soulattri*; therefore, *C. solomonense* is reduced to synonymy under *C. soulattri*.

133. *Calophyllum waliense* P. F. Stevens, sp. nov.

FIGURE 38, e-g.

A speciebus aliis Calophylli quibus laminis cordatis habent a costa in pagina superiore laminae depressa et putamine signato parietibus circa 2 mm. crassis obturamento basali proviso, differt.

Tree 20-25 meters tall; trunk without buttresses; outer bark cream-brown to dark brown, slightly fissured; latex yellow, clear, sticky.

Twigs flattened, 2.5-5.5 mm. across, 6-angled, soon becoming rounded, with obscure horizontal lines at nodes, drying brown, sparsely brown-farinose when young; axillary innovations lacking basal scars; internodes 1.5-3.5(-7) cm. long; uppermost pair of axillary buds subacute, to 2.5 mm. long, erect to spreading; terminal bud plump to narrowly conical, 0.8-1.3 cm. long, with gray-brown, crustaceous indumentum (hairs, FIGURE 37, p), underdeveloped internode absent (-2 mm. long). Petiole 3-5 mm. long, concave above and convex below, glabrous; lamina elliptic to suboblong, (9-)14.5-27 by (3.8-)6-10.3 cm., rounded to acute at apex, cordate at base, undulate and narrowly recurved at margin, coriaceous, drying dark brick to olivaceous above and sabelline below, farinose on midrib below when young, the midrib above gradually narrowed from base, depressed, 0.5-1.3 mm. wide at midpoint, below raised, becoming raised toward apex, angled (becoming striate toward base), the venation manifest on both surfaces, raised, latex canals sometimes raised, 4 to 7 veins/5 mm., at base to 14 veins/5 mm., angle of divergence 75-80°. Inflorescences from foliate axils near ends of twigs, with 5 to 7 flowers, unbranched, the axis 1.9-3.2 cm. long, flattened and strongly 4-angled, glabrous, lowest internode 3-9 mm. long; bracts not known; pedicels 1.3-1.5 cm. long, glabrous. Old flower only known, (?)hermaphroditic; outer tepals broadly ovate, ca. 6 by 5 mm., strongly concave, inner ones obovate, to 12.5 by 4.5 mm.; stamens (?)numerous, the anthers oblong, ca. 1.3 mm. long, subrounded at apex; ovary ca. 2.5 mm. long, the style ca. 2.5 mm. long, the stigma peltate, ca. 2 mm. across. Fruit broadly ovoid, ca. 3.8 by 3.3 cm. when preserved in spirit, obtuse at apex, drying dark brown, broadly corrugate-wrinkled; outer layer not detaching cleanly from stone, ca. 1.5 mm. thick, compact; stone spherical, ca. 3 by 2.8 cm., subobtuse at apex, the walls ca. 2 mm. thick, smooth, with 4 or 5 longitudinal markings, outer layer persisting over them, basal plug ca. 10 mm. across; spongy layer absent.

TYPE: Papua New Guinea, Bismarck Archipelago, Manus Island, Wali River near Derimbat, 100 m., 3 July 1973, LAE 52411 coll. Foreman (holotype, A; isotypes, CANB, L, LAE).

DISTRIBUTION. Papua New Guinea, known only from Manus Island (Map 40).

ADDITIONAL SPECIMENS SEEN. **Papuasias**. PAPUA NEW GUINEA. Manus: ridge between Liap and Derimbat, 100 m., LAE 59253 (A, L, LAE), LAE 59255 (A, L, LAE).

ECOLOGY. Lowland forest on ridges ca. 100(–7550) m. alt. Young fruit July and October; fruit greenish.

GERMINATION AND YOUNG PLANT. The radicle pushes out the basal plug. The seedling has two pairs of leaves separated by an internode ca. 1.3 cm. long. Subsequent internodes are well developed, the plant is erect, and the terminal bud is functional. (Seedlings from LAE 52411.)

*Calophyllum waliense* is a distinctive species. Its robust twigs are six-angled, and its terminal buds have furfuraceous indumentum. The lamina is large, cordate at the base, and with a depressed midrib on the upper surface. The fruits are large, and the thick-walled stone has four or five longitudinal stripes and a basal plug. The specific epithet is derived from the Wali River, where the type specimen was found.

*Calophyllum waliense* is superficially similar to *C. grandiflorum*, from Java, but in the latter species the twigs dry yellowish, rather than brown, the thinner leaf blade lacks a depressed midrib and has less dense venation, and the inflorescence and flowers are much larger. The structure of the fruit is different, and the seed of *C. grandiflorum* germinates by breaking the stone to one side of the base, the seedling having only a single pair of leaves. *Calophyllum waliense* is related neither to *C. grandiflorum* nor to members of the *C. venulosum* group.

The closest relative of *Calophyllum waliense* is probably *C. solomonense*: their twigs and terminal buds are similar, and their leaf blades dry a similar color with the very margin often brighter than the rest of the lamina. The stones of both species have thick walls and a basal plug. *Calophyllum waliense* differs from *C. solomonense* most obviously in its cordate lamina with a depressed midrib on the upper surface and in its longitudinally marked stone.

*Calophyllum waliense* may grow at 550 meters on Mt. Dremsel, Manus. The sheet of LAE 53644 at Leiden has a shoot of *C. waliense* (with a number tag) as well as one of *C. euryphyllum*; all other duplicates of this number that I have seen are of the latter species.

134. *Calophyllum euryphyllum* Lauterb. Bot. Jahrb. 58: 14. 1922; T. C. Whitmore, Gard. Bull. Singapore 22: 12. 1967, *pro parte*; P. F. Stevens, Austral. Jour. Bot. 22: 365, fig. 4. 1974. TYPE: Nordost-Neu-Guinea [Papua New Guinea], Lagerberg, Augusta Fluss Station, Sept. 1887, *Hollrung* 761 (holotype, B (destroyed); isotype, WRSJ).

*C. peekelii* auct., non Lauterb.; T. C. Whitmore, Gard. Bull. Singapore 22: 11. 1967, *pro parte*.

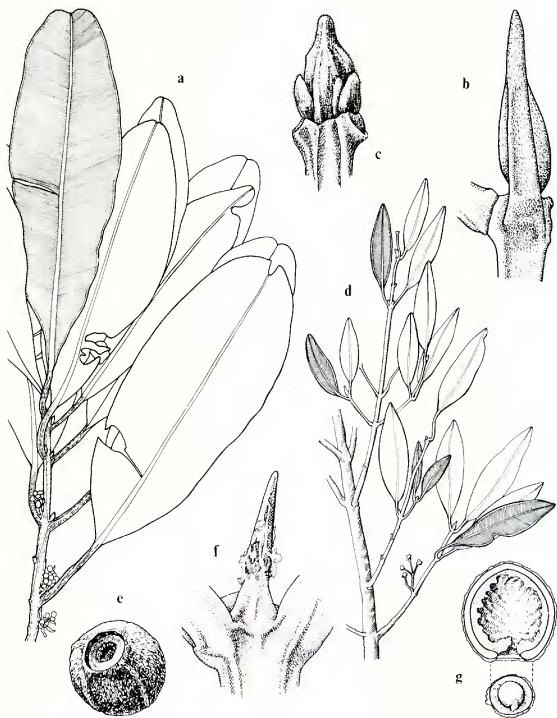


FIGURE 38. a, b, *Calophyllum goniocarpum*: a, bb 17942, habit,  $\times 0.5$ ; b, bb 33771, terminal bud,  $\times 3$ . c, d, *Calophyllum* sp. 143 (NGF 24444): c, terminal bud,  $\times 6$ ; d, habit,  $\times 0.5$ . e-g, *C. waliense* (LAE 52411). e, g, stone,  $\times 0.75$ : e, from outside; g, longitudinal section, plug displaced. f, terminal bud,  $\times 3$ .

Tree 12–26 meters tall, d.b.h. to 100 cm.; trunk without or with only very short buttresses; outer bark brown, becoming fissured,  $\pm$  scaling, the inner surface dark red; under bark buff, reddish buff, or red-brown; inner bark red; latex clear yellow (rarely yellowish white), sticky.

Twigs strongly flattened, 2.5–6.5 mm. across, 4-angled and with two additional raised lines, drying dark brown, rather persistently farinose to short-tomentose; axillary innovations lacking basal scars; internodes (1)3–10(–16) cm. long; uppermost pair of axillary buds pointed, (1)3–10(–14) mm. long, spreading, supernumerary axillary buds often present; terminal bud subconical, 0.7–1.6 cm. long, with brown, puberulo-tomentose indumentum (hairs, FIGURE 37, w–y), underdeveloped internode (2)4–11 mm. long. Petiole 1.6–3.5(–4.2) cm. long, broadly and usually deeply concave above, angled below, usually persistently puberulent; lamina ovate to subelliptic, (6.5)–8.5–19 by (1.5)–5.4–12 cm., subretuse to subacuminate at apex, broadly rounded to cuneate or acute at base, at most slightly and distantly undulate and slightly recurved at margin, coriaceous, drying sabelline to near olivaceous (with grayish covering) above and fulvous to sabelline-sepia below, glabrescent or subpersistently farinose-puberulent on midrib on both surfaces, the midrib above quickly narrowed near base, becoming  $\pm$  raised, the center strongly sulcate at first, 0.3–0.6 mm. wide at midpoint, below strongly raised, angled, the venation  $\pm$  obscure on both surfaces, or subapparent below, slightly raised, latex canals sometimes also slightly raised below, 9 to 13 veins/5 mm., angle of divergence 60–80°. Inflorescences from upper foliate axils, sometimes 2 per axil, with 5 to 15 flowers, usually unbranched (flabellate and/or with 3-flowered branches to 1.2 cm. long), the axis 1.2–5 cm. long, densely puberulent, lowest internode 0.5–1.3 cm. long; bracts ovate, 3–5.5 mm. long, deciduous; pedicels 0.7–1.2 cm. long, densely puberulent. Flower (?)hermaphroditic; tepals 4, the outer pair ovate, 8–9.5 by 6–7.5 mm., densely puberulent on back, the inner pair elliptic-ovate, 8–10 by 7–8 mm., sometimes puberulent in band down back; stamens 70 to 180, the filaments to 6 mm. long, the anthers oblong, 2–3 mm. long, apiculate; ovary to 3 mm. long, densely puberulent, the style ca. 3.5 mm. long, glabrous, the stigma peltate, ca. 3 mm. across, irregularly lobed. Fruit subspherical, 2.8–6 by 2.8–6 cm., rounded at apex, drying snuff-brown, rather closely and shallowly wrinkled; outer layer not detaching cleanly from stone, 2–5 mm. thick, compact; stone spherical, 2.5–5.5 by 2.5–5.5 cm., rounded at apex, the walls 0.5–1.4 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Northern New Guinea, the Bismarck Archipelago, and the Aru Islands (MAP 43).

SELECTED SPECIMENS SEEN. **Papuasias.** IRIAN JAYA. Aru: Wakatoebi, P. Oedjir, 20 m., *bb* 25490 (L, MO). Vogelkop: Doré, *van Hasselt* 6 (BO). Geelvink Bay: Meos Num, 10 m., *BW* 15513 (L). PAPUA NEW GUINEA. Morobe: Umboi Is., Liplip-Mambi R. area, 200 m., *LAE* 66098 (L, LAE). For additional specimens, see Stevens, *loc. cit.*

ECOLOGY. Usually primary rainforest, sometimes over coral; to 610 m. alt. Flowering August and September; fruiting May, June, and November (fruit greenish).

GERMINATION AND YOUNG PLANT. The radicle breaks the stone wall to one side of the base. The seedling has two pairs of leaves separated by an internode 0.5–2 cm. long. Subsequently produced internodes are much longer, the terminal bud is functional, and the plant is erect. (*LAE* 53644, 58539, 59189, *Noona Dan Exp.* 2014; see also Stevens, *loc. cit.*)

*Calophyllum euryphyllum* is a very distinctive species with its strongly flattened, usually puberulent twigs; well-developed and spreading uppermost pair of axillary buds; rather large, ovate leaf blades with inconspicuous venation; flowers with four tepals and a puberulent ovary; and spherical fruits that have a compact outer layer and a thick-walled stone lacking a basal plug. The leaf blades are quite broad; hence Lauterbach coined the epithet *euryphyllum* (Greek—*eury*s, “broad,” and *phyll*on, “leaf”).

UPNG 2019, from the Kiriwina Islands, has the facies of *Calophyllum euryphyllum*, but the midrib on the upper surface of the lamina narrows gradually from the base, and the flowers have nine tepals. The specimen is rather poor, and further collections are needed to establish the identity of this plant.

The relationships of *Calophyllum euryphyllum* are unclear. It is possibly close to *C. papuanum* and its relatives, which have very different terminal buds, fruits, and germination; to *C. obscurum*, which has much smaller leaves and fruits; and to *C. costatum*, which also has small leaves and fruits that probably have a basal plug. *Calophyllum carrii* may also be a member of this group; its fruits are unknown, but its leaf has a depressed midrib. Hairs of all of these taxa are much branched and are generally similar.

135. *Calophyllum papuanum* Lauterb. Bot. Jahrb. 58: 9. fig. 2. 1922; Engler in Engler & Prantl, Nat. Pflanzenfam. ed. 2. 21: fig. 82. 1925; A. C. Smith, Jour. Arnold Arb. 22: 348. 1941; Hartley *et al.* Lloydia 36: 276. 1973; P. F. Stevens, Austral. Jour. Bot. 22: 382. 1974. TYPE: Süd-Neu-Guinea [Irian Jaya], südliches Hellwig-Gebirge, 1450 m., 23 Dec. 1912, *Pulle* 799 (holotype, B; isotypes, BO, K, L).

FIGURES 4, a; 6, a, b.

Tree (5–)16–40 meters tall, d.b.h. to 92 cm.; trunk sometimes with spurs or buttresses to 3 meters; outer bark dark gray to brown, becoming strongly fissured and flaking when mature, the inner surface purplish to red-black; under bark dark red to pink; inner bark dark to pale red; latex clear yellow, very sticky (light yellow, milky). Crown conical at first, becoming irregular, spreading.

Twigs strongly flattened, 2–5(–8) mm. across, (rarely 2-) 4- or 6-angled, often with inconspicuous transverse raised line at nodes, drying brown, subpersistently tomentose (rarely farinose-puberulent); axillary innovations

lacking basal scars; internodes 1–6 cm. long; uppermost pair of axillary buds  $\pm$  pointed, 2.5–4.5 mm. long, erect; terminal bud strongly flattened, 7–15 mm. long, with brown, tomentose indumentum (hairs, FIGURE 37, u, v), underdeveloped internode to 3 mm. long. Petiole 0.6–2.5 cm. long, narrowly concave above, angled below, usually subpersistently tomentose; lamina ovate to subobovate, subcuneiform or suboblong, (2.4–)6.5–17(–22) by (1.4–)3.5–8 (–11) cm., subacute to rounded at apex, cuneate to rounded at base, slightly undulate and not recurved to slightly so at margin, coriaceous, drying umber to olivaceous (shiny) above and umber to olivaceous below, when young with indumentum on both surfaces, often persistently subtomentose on lower surface, the midrib above usually narrowing gradually from base,  $\pm$  depressed at first, soon becoming  $\pm$  raised, (0.2–)0.4–0.8 mm. wide at midpoint, below raised, angled, the venation above subobscure, below  $\pm$  apparent, raised, 5 to 12 veins/5 mm., angle of divergence 60–80°. Inflorescences from foliate axils near ends of twigs, with (1 to) 3 to 7 (to 11) flowers, usually unbranched, the axis (0.3–)0.7–1.5 cm. long, short-tomentose to sparsely puberulent, lowest internode 0.3–1.2 cm. long; bracts ovate, to 5.5 mm. long, soon deciduous; pedicels 0.5–1.3 cm. long, puberulent to subtomentose. Plant (?)dioecious; tepals usually 8, the outer pair broadly ovate, 4.5–9.2 by 4.5–9 mm., short-tomentose on back, the inner ones oblong to obovate, 6–14 by 4–12 mm., at least outer pair puberulo-tomentose on back; stamens (70 to) 150 to 300, in staminate flower the filaments 3.5–10 mm. long, the anthers oblong, 2.3–5 mm. long, apiculate, sometimes papillate on apiculus, in pistillate flower filaments ca. 3 mm. long, anthers 0.5–1 mm. long; ovary 2.3–5.5 mm. long in pistillate flower, smaller in staminate flower, tomentose, the style 1.5–2.5 mm. long, the stigma peltate, 3–5.5 mm. across (absent in staminate flower). Fruit  $\pm$  spherical, 2–4 by 2–4 cm., rounded at apex, drying brown, smooth; outer layer not detaching cleanly from stone, 1.5–5 mm. thick,  $\pm$  compact, but air spaces developing near stone; stone subspherical, 1.4–3 by 1.4–3 cm., rounded (obscurely 2- to 4-angled) at apex, the walls 1–2.5 mm. thick, barely developed just to one side of base, irregularly pock marked; spongy layer thin.

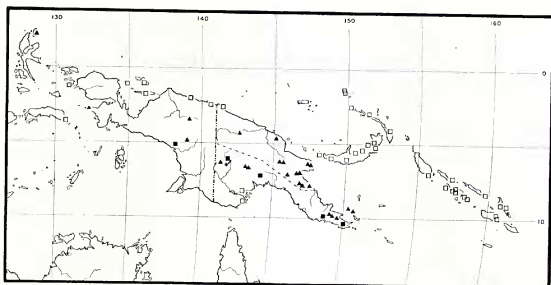
DISTRIBUTION. Moluccas, mainland New Guinea, and Fergusson and Goodenough islands (MAP 42).

SELECTED SPECIMENS SEEN. **Moluccas.** MOROTAI: G. Sangowo, 800 m., *Koster-mans 1073* (A, BO, L). **Papuasias:** see Stevens, *loc. cit.* Also, PAPUA NEW GUINEA, Papuan islands: E. Slopes Mt. Kilkerran (Woiatabu), NE. Fergusson Is., 1600 m., *LAE 68957* (A).

ECOLOGY. Usually canopy tree of colline or montane forest often dominated by Fagaceae, rarely in more or less swampy forest or depleted *Agathis* forest over limestone with thick clay cover; (2–)120–1830 m. alt. Flowering January to March, May, July, September, November, and December (flower scented); fruiting January, April, and September (fruit greenish).

GERMINATION AND YOUNG PLANT. The radicle pushes through the area of very thin stone just to one side of the base (cf. Stevens, *loc. cit.*). The seedling





MAP 42. Distribution of *Calophyllum papuanum* (triangles), *C. vexans* (open squares), and *C. vexans* variant (solid squares) in Papuaia.

has three (rarely two) pairs of leaves separated by well-developed internodes; the lowest pair of leaves may drop off well before the others. Subsequent internodes are also well developed, the terminal bud is functional, and growth is erect. Germination is similar in fruits with angled and with rounded stones (NGF 10331, LAE 54757, Pullen 1125—rounded; LAE 58071—angled).

LOCAL USE. The wood is used in building.

*Calophyllum papuanum* is a very distinctive species with a flattened terminal bud and medium-sized leaf blades that usually have subpersistent, puberulotomentose indumentum over the lower surface. The flower has a tomentose ovary, and the rather large, spherical fruits are 2–4 cm. long and have a pock-marked stone. The specific epithet is taken from “Papua,” which once referred to the entire island of New Guinea.

*Calophyllum papuanum* is related to *C. pauciflorum* and *C. vexans*; for the differences separating these species, see TABLE 16.

Plants of *Calophyllum papuanum* growing at higher altitudes have angled stones; those growing at lower altitudes have rounded ones (Stevens, *loc. cit.*). Other interesting variation is shown by specimens from the hills south of the Sepik River. These specimens have rather small, narrow, subovate leaf blades that are minutely rounded at the base; fruits are not known from plants with leaves of this type.

136. *Calophyllum pauciflorum* A. C. Smith, Jour. Arnold Arb. **22**: 348. 1941; Hartley *et al.* Lloydia **36**: 276. 1973; P. F. Stevens, Austral. Jour. Bot. **22**: 384. 1974. TYPE: New Guinea, Mt. Alok, Yunzaing, 4500 feet [1372 m.], 21 April 1936, J. & M. S. Clemens 2378 (holotype, A).

*C. congestiflorum* A. C. Smith, Jour. Arnold Arb. **22**: 349. 1941. TYPE: Netherlands New Guinea [Irian Jaya], 15 km. south-west of Bernhard Camp, Idenburg River, 1800 m., Jan. 1939, *Brass & Versteegh 11902* (holotype, A; isotypes, BO, BRI, L, LAE).

*Calophyllum* sp. Lane-Poole, Forest Res. Terr. Papua New Guinea, 117. 1925.

Tree 8–36 meters tall, d.b.h. to 48 cm.; trunk not buttressed (fluted at base); outer bark brown to dark brown (light gray), fissured and scaling, the inner surface brown to dark brown; under bark dark red; inner bark reddish brown; latex clear yellow, sticky (gray, cloudy).

Twigs strongly flattened, 1.25–3 mm. across, 4- or 6-angled (2-angled when older), with inconspicuous transverse raised line at nodes, drying brown, glabrous or sparsely brown-farinoso; axillary innovations lacking basal scars; internodes 0.3–5 cm. long, to 10 cm. long on leader shoots; uppermost pair of axillary buds  $\pm$  pointed, 1–4.5 mm. long, at first inconspicuous; terminal bud strongly flattened, 5–11 mm. long, with brown, farinose-puberulent indumentum (hairs, FIGURE 39, a), underdeveloped internode absent (–2 mm. long). Petiole 2–8 mm. long, deeply channeled above, angled below,  $\pm$  glabrous when mature; lamina rhombiform, cuneiform, elliptic, or obovate, 2.5–5.5 (–9.5) by 0.9–2.5 (–4) cm., obtusely pointed to rounded at apex, cuneate at base, slightly undulate or recurved at margin, coriaceous, drying umber to cinnamon-sepia above and fulvous-umber to sabelline below, when young sparsely puberulent on both surfaces, glabrescent or persistently sparsely farinose near midrib below, the midrib above narrowed gradually from base,  $\pm$  depressed at first with margins raised, becoming  $\pm$  raised with center sulcate, (0.3–)0.4–0.55 mm. wide at midpoint, below raised, angled, the venation subobscure on both surfaces, slightly raised (rarely impressed), 7 to 12 veins/5 mm., angle of divergence 50–70°. Inflorescences from upper foliate axils (very rarely terminal), with 3 to 5 flowers, unbranched, the axis 0.3–1.2 (–1.5) cm. long, farinose-puberulent at least toward base, lowest internode 2–4 mm. long; bracts ovate to elliptic, 2.5–4.5 mm. long, deciduous; pedicels 2–6 mm. long, glabrous or sparsely farinose-puberulent. Plant (?)dioecious; tepals 8 (rarely 7), the outer pair ovate, ca. 3.75 by 3.5 mm., sometimes farinose on back toward base, the inner ones oblong to obovate, to 5.5 by 6.5 mm.; stamens 70 to 125, the filaments to 4.5 mm. long, the anthers suboblong, 0.7–1.7 mm. long, apiculate; ovary 1–2 mm. long, the style ca. 1 mm. long, the stigma peltate, 1.5–2.5 mm. across, radiate. Fruit spherical, 1.5–1.9 by ca. 1.7 cm., rounded at apex or apiculate, drying brown-vinaceous, smooth or finely striate; outer layer not detaching cleanly from stone, 3–4.8 mm. thick,  $\pm$  compact; stone spherical, 1–1.3 by 1–1.3 cm., usually rather obscurely 2- or 3-angled, rounded at apex, the walls 0.7–1.5 mm. thick, thinner just to one side of base, pitted; spongy layer thin.

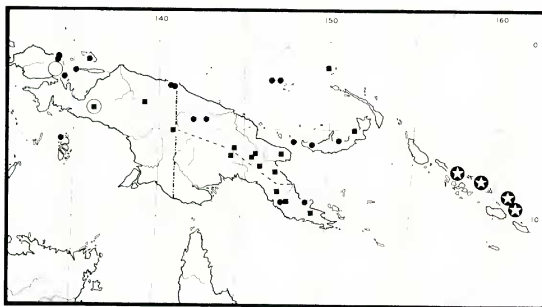
DISTRIBUTION. New Guinea, excluding the Vogelkop Peninsula (MAP 43).

SELECTED SPECIMENS SEEN. **Papuaia**: see Stevens, *loc. cit.*

ECOLOGY. Lower or sometimes upper montane forest, often dominated by

TABLE 16. Some differences between *Calophyllum papuanum*, *C. pauciflorum*, and *C. vexans*.

	<i>C. papuanum</i>	<i>C. pauciflorum</i>	<i>C. vexans</i>
TERMINAL BUD STRONGLY FLATTENED	+	+	+ -
TWIG THICKNESS (mm.)	2-5(-8)	1.25-3	1.5-2.5
LAMINA			
LENGTH (cm.)	(2.4-)6.5-17(-22)	2.5-5.5(-9.5)	3.4-12.5
INDUMENTUM ON LOWER SURFACE			
± PERSISTENT, SUBTOMENTOSE	+(-)	-	-
VENATION ON UPPER SURFACE OBSCURE	+	+	-(+)
FLOWER			
ANTHER LENGTH, STAMINATE FLOWER (mm.)	2.3-5.5	0.7-1.7	1.8-2.6
HAIRS ON PISTIL	Dense on ovary, some on style	None	Sometimes few on style
FRUIT LENGTH (cm.)	2-4	1.5-1.9	1.8-2.7



MAP 43. Distribution of *Calophyllum euryphyllum* (solid circles), *C. hirasimum* (open circles), *C. pauciflorum* (squares), and *C. obscurum* (stars in solid circles) in Papuaia.

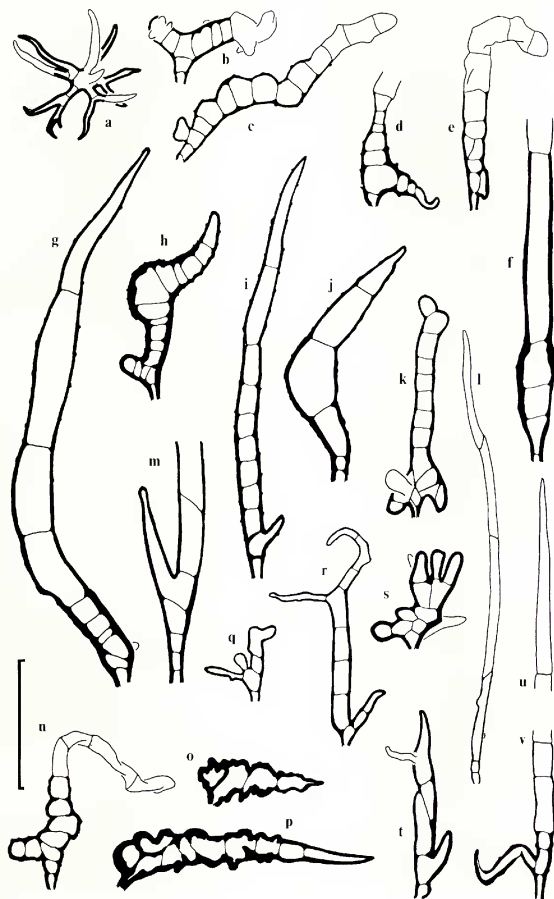
*Castanopsis* or *Nothofagus*; 1550–2900 m. alt. Flowering January and April; fruiting January, February, and September (fruit greenish).

**GERMINATION AND YOUNG PLANT.** The radicle probably breaks through the stone wall just to one side of the base. The seedling has three pairs of leaves separated by well-developed internodes. Subsequently produced internodes are longer, the young plant is erect, and the terminal bud is functional. (Pers. obs.)

**LOCAL USE.** The wood is good as a green fuel.

*Calophyllum pauciflorum* is a distinctive species recognizable by its flattened terminal buds and its small, often cuneiform-rhombiform leaf blades that appear glabrous when mature. The midrib on the upper surface of the blade

FIGURE 39. Hairs (from terminal bud, unless otherwise noted). a, *Calophyllum pauciflorum* (Hartley 13122), from above. b, c, *C. hirasimum*, hairs to ca. 420  $\mu\text{m}$ . long; b, BW 14295; c, Kanehira & Hatusima 13980. d–f, *C. heterophyllum*, bases birefringent: d, Brass 7385; e, Kalkman 4554; f, Brass 7099. g–j, *C. goniocarpum*, base or entire hair birefringent: g, LAE 56132; h, NGF 1387; i, Brass 27669; j, LAE 68580. k, s, *C. morobense*: k, NGF 46766; s, NGF 24490. l, m, *C. trachycaule* (Brass 5654), slightly birefringent, walls sometimes rough. n, *Calophyllum* sp. 143 (NGF 24444), basal projection sometimes lacking. o, *C. suberosum* (NGF 37159). p, *C. persimile* (NGF 18303), from stem. q, r, t, *C. streimannii*: q, LAE 52775; r, t, NGF 24285. u, v, *C. rufinerve* (Kanehira & Hatusima 12218), slightly birefringent, apex and base of hair ca. 900  $\mu\text{m}$ . long. Scale = 120  $\mu\text{m}$ . (in l, scale = 240  $\mu\text{m}$ .)



narrows gradually from the base, and the venation is more or less obscure. The inflorescences have only three to five flowers, and the fruits are less than 2 cm. long. The few-flowered inflorescences suggested the specific epithet.

*Calophyllum pauciflorum* is related to *C. vexans* and especially to *C. papuanum*; for the differences separating these taxa, see TABLE 16. The differences are mostly in the size of parts and the prominence of the indumentum, but there is never any trouble in identifying specimens. Although specimens of *C. papuanum* from higher altitudes have smaller leaves and fruits with angled stones (and in these characters approach *C. pauciflorum*), in indumentum development, venation prominence, and midrib type, they are like specimens of *C. papuanum* from lower altitudes. The anthers of Carr 14143 (*C. papuanum*, collected at 1585 m. alt.) are 2.3–2.5 mm. long—considerably longer than those of *C. pauciflorum*. In most characters of wood anatomy studied by van der Graaff and Baas (1974), the two were indistinguishable, except that *C. papuanum* had wider vessels.

The similarities between the three taxa (flattened terminal bud, twig type, branched to almost stellate hairs, more or less well-developed dioecy, mushroomlike stigma, and pocked, often angled, stone) are considerable, and it is of interest to see that the three taxa replace one another geographically and/or ecologically. Although *C. papuanum* and an imperfectly known form of *C. vexans* grow within a few hundred yards of each other in apparently similar habitats near Kiunga in the Western Province of Papua, the identity of the form of *C. vexans* is in doubt (see the discussion after that species).

Specimens of *Calophyllum hirasimum* have been confused with *C. pauciflorum*; this is discussed further under *C. hirasimum*.

More collections of *Calophyllum pauciflorum* are needed to evaluate the variation in stamen and pistil size and to ascertain whether or not the species is dioecious (see also Stevens, *loc. cit.*). There are a few stamens persisting at the base of an immature fruit on Kalkman 4318; these have anthers ca. 1.7 mm. long—the size of anthers in staminate flowers. However, the anthers have apparently not dehisced, and so the fruits may have been produced by functionally pistillate flowers.

137. *Calophyllum vexans* P. F. Stevens, Austral. Jour. Bot. 22: 407. fig. 16. 1974. TYPE: Solomon Islands, New Georgia group, North-west Shortland Island, Kupala Point, 10 feet [3 m.], 7 March 1965, BSIP 13206 coll. Runikera et al. (holotype, LAE; isotype, L).

*C. gaimanum* P. F. Stevens, Austral. Jour. Bot. 22: 367. fig. 5. 1974. TYPE: Papua, east bank of Lower Fly River, Nov. 1936, Brass 8337 (holotype, LAE; isotypes, A, BO, BRI, G, K, L).

*Calophyllum* sp. Lane-Poole, Forest Res. Terr. Papua New Guinea, 117. 1925; F. S. Walker, Forests Brit. Solomon Is. Prot. 123. 1945.

*C. cerasiferum* auct., non Vesque; T. C. Whitmore, Guide Forests Brit. Solomon Is. 77. 1966, Gard. Bull. Singapore 22: 13. 1967.

Tree 12–35 meters tall, d.b.h. to 60 cm.; trunk sometimes with buttresses or stilt roots to 1.7 meters tall; outer bark brown, smooth at first, becoming

fissured and  $\pm$  scaly, the inner surface blackish; under bark red to red-brown; inner bark reddish, fibrous; latex yellow (white or greenish), clear (turning cloudy), sticky.

Twigs flattened, 1.5–2.5 mm. across, 4-angled to subulate, with inconspicuous transverse raised line at nodes, drying brown, farinose-puberulent at least when young, or subglabrous; internodes 0.5–8 cm. long; axillary innovations lacking basal scars; uppermost pair of axillary buds  $\pm$  pointed, 1–4 mm. long, erect; terminal bud strongly flattened to conical, (3.5–)6–12 mm. long, with subcrustaceous to puberulent, brown indumentum (hairs, FIGURE 37, q–t), underdeveloped internode 0.5–3.5 mm. long. Petiole 0.4–1.4 cm. long,  $\pm$  deeply concave above, convex to angled below, glabrous when mature; lamina elliptic to trapeziform, subovate, subobovate, or oblong, 3.4–12.5 by 1.2–4.7 cm., acute to subacuminate at apex, acute to cuneate at base, or rounded toward and attenuate at very base, not undulate to moderately so and recurved at margin, coriaceous, drying sepia to near sabelline-olivaceous above and sepia to honey below, glabrescent or subpersistently farinose on and near midrib, the midrib above narrowed gradually from base (depressed at first), at least margins soon becoming raised, center usually clearly sulcate, (0.1–)0.3–0.6(–0.7) mm. wide at midpoint (disappearing up to 5 mm. below apex), below raised, striate to angled, the venation apparent (rarely subobscure), raised, (6 to) 8 to 11 (to 16) veins/5 mm., angle of divergence (40–)55–75°. Inflorescences from foliate axils (rarely terminal on short, leafy axillary shoots), sometimes 2 per axil, with 3 to 5 (rarely to (?)7) flowers, unbranched, the axis 0.1–1.3 cm. long, subglabrous or farinose-puberulent, lowest internode 1–6 mm. long; bracts ovate, ca. 3.5 mm. long, deciduous; pedicels 2–8.5 mm. long, glabrous or sparsely farinose. Plant (?)dioecious; tepals 4 to 8, the outer pair ovate, 2.7–5 by 2.8–4 mm., sparsely subpuberulent on back toward base, the inner ones elliptic to obovate, 5–6 by 2.5–4.5 mm.; stamens 30 to 105, the filaments 3–4 mm. long, connate at very base, the anthers oblong, 1.8–2.6 mm. long, apiculate, sometimes papillose on apiculus in pistillate flowers; ovary 1–2 mm. long, the style 1.2–1.7 mm. long, sometimes with sparse hairs, at least in staminate flowers, the stigma peltate, 1.8–2.5 mm. across, radiate, sometimes absent in staminate flowers. Fruit spherical to ovoid-ellipsoid, 1.8–2.7 by 1.4–2.2 cm., rounded at apex, drying brown-vinaceous, smooth to sharply and shallowly wrinkled; outer layer not detaching cleanly from stone, 1.5–2.75 mm. across, compact; stone ellipsoid to subovoid, (1–)1.4–1.7 by (0.75–)0.9–1.4 cm., rounded at apex, sometimes subangled, the walls 0.7–2.2 mm. across, pocked; spongy layer thin.

DISTRIBUTION. Throughout Papuasias at suitable elevations (MAP 42).

SELECTED SPECIMENS SEEN. **Moluccas.** SERAM: Kiandarat, 60 m., *bb* 25839 (L). **Papuasias:** see Stevens, *loc. cit.*, *C. gaimanum* and *C. vexans*. Also, IRIAN JAYA. Geelvink Bay: Eil. Biak, Seroei, 50 m., *bb* 30923 (L, SING). PAPUA NEW GUINEA. Morobe: Umboi Is., Lip Lip–Mambi R. area, 200 m., *LAE* 66100 (K, L, LAE).

**ECOLOGY.** Usually well-drained lowland or colline rain forest, but swampy forest in Western Province; to 900(-1450) m. alt. Flowering November to July (flower scented); fruiting January, April, June, and October (fruit greenish).

**GERMINATION AND YOUNG PLANT.** The radicle emerges through the area of thin wall just to one side of the base of the stone (*NGF 12351*). The young plant is erect, and the terminal bud is functional.

**LOCAL NAME.** "Kaumanu" (Kwara'ae, Solomon Islands).

*Calophyllum vexans* can be recognized by its often flattened terminal bud, its angled twigs, and its leaf blades, which are widest near the middle and which have rather distinct venation and a midrib that is prominent on the upper surface and that narrows gradually from the base. The inflorescence is small, and the plants appear to be dioecious; the fruits have a pock-marked stone. Circumscribing the limits of this taxon has been difficult; hence the epithet *vexans* ("vexing," "annoying").

The differences separating *Calophyllum vexans* from its relatives, *C. papuanum* and *C. pauciflorum*, are listed in TABLE 16.

Although *Calophyllum gaimanum* is reduced to synonymy under *C. vexans*, it could represent a taxon that may have to be recognized formally when the variation within this rather variable species is better understood (see also Stevens, *loc. cit.*). The type of *C. gaimanum* and *NGF 17736* (from the Western Province), and specimens from Umboi Island, New Britain, and New Ireland (but not from Mussau Island) all have a strongly flattened terminal bud and rather narrowly elliptic leaves. In what are presumably staminate flowers, the pistil is relatively well developed; there may be hairs on the style (e.g., *Brass 8337*, *LAE 51230*) or not (e.g., *NGF 46049*). I have not seen hairs on the styles of pistillate plants (e.g., *LAE 52191*). *NGF 27406*, from New Britain, lacks a strongly flattened terminal bud but in other respects agrees with the rest of this group. On *Brass 8337* and *NGF 17736* the midrib usually disappears up to 5 mm. below the apex of the lamina, but this seems to be the only difference between the Papuan specimens and those from the Bismarck Archipelago. Some axillary inflorescences of *Brass 8337* terminate short, leafy lateral shoots; similar inflorescences were noticed on *Noona Dan Expedition 1127*, collected on Mussau Island.

Specimens from the Solomon Islands have a broader lamina and lack an obviously flattened terminal bud; specimens from Irian Jaya have a similar terminal bud, but can be distinguished by other characters such as color of the dried plant and venation density of the lamina.

All specimens of *Calophyllum vexans* collected in Papua (except *Brass 8337* and *NGF 17736*) form another distinct group that has subulate twigs and leaves with rather short petioles; the midrib on the upper surface of the living leaf is dark green, and the lamina is rather soft and fleshy and has an undulate margin. The midrib on the upper surface of the living leaf of the form on New Britain is only slightly raised and is yellowish white; the blade is more coriaceous, and the margin is not undulate. *bb 25839* (Seram)



probably belongs to the same group as the Papuan specimens; flowers of the Papuan specimens are not known.

There is discussion of further minor variation within *Calophyllum vexans* in Stevens (*loc. cit.*), as well as details of size variation of stamens and pistils in staminate and pistillate flowers.

138. *Calophyllum hirasimum* P. F. Stevens, sp. nov.

FIGURE 36, j-l.

*C. congestiflorum* auct., non A. C. Smith; Kanehira & Hatusima, Bot. Mag. Tokyo 56: 560. fig. 1. 1940.

A speciebus aliis Calophylli in lamina suboblunga, inflorescentiis paucifloribus bracteis subpersistentibus foliaceis, floribus cum 4, raro 6, tepalis, et fructu ellipsoideo circa 1.4 cm. longo putamine parietibus circa 2 mm. crassis, differt.

Tree 4-18 meters tall, d.b.h. to 30 cm.; bark not known.

Twigs flattened, 1-2 mm. across, 4-angled when young, becoming subterete, drying dark brown, subpersistently farinose; axillary innovations lacking basal scars; internodes 1-6 cm. long; uppermost pair of axillary buds  $\pm$  rounded, (1-)1.5-2 mm. long, erect; terminal bud conical, 2-6(-9) mm. long, with brown, tomentose to subcrustaceous indumentum (hairs, FIGURE 39, b, c), underdeveloped internode to 1 mm. long. Petiole 5-10 mm. long, usually broadly concave above, convex below, farinose when young; lamina elliptic to oblong-elliptic or obovate, 2.8-6.7 by 1.4-3.2 cm., rounded at apex, acute at base, slightly undulate and recurved at margin, coriaceous, drying dark brick to umber (shiny) above and sepia to sabelline below, the midrib subpuberulent on both surfaces,  $\pm$  persistently so below, the midrib above narrowed near base, raised, 0.07-0.15 mm. wide at midpoint, below raised, angled to striate, the venation subapparent above and apparent below, raised, 9 to 12 (to 15) veins/5 mm., angle of divergence 65-70°. Inflorescences from foliate axils near ends of twigs, with 3 to 7 flowers, not branched, the axis 0.8-2.8 cm. long;  $\pm$  puberulent toward base, lowest internode 0.4-1.4 cm. long; bracts often foliaceous, to 2.8 by 1.5 cm., subpersistent; pedicels 0.5-1 cm. long, glabrous. Flower (?)hermaphroditic; tepals 4 (or 6), sometimes glabrous, the outer pair suborbicular, 3.5-4 by 3.5-4 mm. (rarely 2.5 by 1.5 mm.), the inner ones elliptic to obovate, to 6.5 by 4 mm.; stamens 50 to 85, the filaments to 2.5 mm. long, almost free, the anthers elliptic, ca. 1 mm. long, retuse at apex; ovary ca. 1.7 mm. long, the style ca. 1.5 mm. long, the stigma peltate, ca. 1 mm. across, 3-radiate. Fruit ellipsoid, ca. 1.4 by 1 cm., mucronulate, drying brown, slightly pruinose, smooth; outer layer not detaching cleanly from stone, thin, disorganized by large air spaces; stone ellipsoid, ca. 1.15 by 0.95 cm., rounded at apex, the walls to 2 mm. thick, somewhat thinner at base, smooth, unmarked; spongy layer thin.

TYPE: Netherlands New Guinea [Irian Jaya], Vogelkop Peninsula, S. slope Mt. Nettoti, path Anjai-Wekari River, 1750 m., 30 Nov. 1961, *van Royen & Sleumer* 7896 (holotype, A; isotype, L).

DISTRIBUTION. Western New Guinea (MAP 43).

ADDITIONAL SPECIMENS SEEN. **Papuasias**. IRIAN JAYA. Vogelkop: Arfak Mts., Angi, by Iray, Lake Giji, 2100 m., *Kanehira* & *Hatusima* 13980 (A, BO); Res. Manokwari, Iraay (Anggi Gigi Meer), 2150 m., BW 265 (CANB, L, LAE); Anggi Gita Lake, Mt. Kongremottie, 2040 m., BW 14100 (A, L), summit of Mt. Misjuk (= Mesenuk), 2150 m., BW 14068 (A, L), Mt. Tidjei, 2100 m., BW 14295 (A, L), mountain summit, 2100 m., *Kostermans* 2490 (BO); Ransiki, Moendi-Berg, 1900 m., BW 2249 (CANB, KEP, L, LAE). Snow Mountains: Wissel Lake region, Is. Maiarie en Tage riviértje, 1750 m., *Eyma* 4953 (A, BO, K, L, SING).

ECOLOGY. Locally abundant small tree of primary *Nothofagus*-conifer forest, remnant Ericaceae-Myrtaceae-*Nothofagus* scrub, or secondary forest; 1750–2150 m. alt. Flowering January, July, and November (floral axis reportedly red); fruiting January and April (fruit purple).

*Calophyllum hirasimum* can be recognized by its small, oblong-elliptic-obovate leaf blades with rather evident venation; its inflorescences, which have subsistent, foliaceous branches; and its ellipsoid fruits, which have a thin outer layer that is disorganized by air spaces, and a smooth, thick-walled stone. The specific epithet combines the names of R. Kanehira and S. Hatusima, who made very important collections, including the only fruiting collection of this species, in western Irian Jaya.

Although confused with *Calophyllum pauciflorum* (BW 265 and 2249 were cited under that species with hesitation by Stevens, 1974a), *C. hirasimum* is not closely related to it. In *C. hirasimum* the terminal bud is not flattened (vs. flattened in *C. pauciflorum*) in the plane of the expanded lamina; the young twigs are basically four-angled (vs. two-angled); the lamina is oblong to obovate (vs. rhombiform); the midrib above narrows quickly (vs. gradually) near the base; the inflorescence axis is extended (vs. compact); the bracts are foliaceous and subsistent (vs. small and deciduous); the fruit is purple (vs. greenish); and the stone is smooth (vs. pock marked). The hairs of the two are also quite different (cf. FIGURES 39, b, c; and 39, a); *C. pauciflorum* has a hypodermis in the leaf, while *C. hirasimum* does not (Stevens, 1974a).

Two specimens, BW 14068 and *Eyma* 4953, have somewhat more coriaceous leaf blades than do the others, and *Eyma* 4953 has a very short pair of uppermost axillary buds; in other respects these specimens are not unusual. BW 2249 and *Kanehira* & *Hatusima* 13980 have rather dense venation (11 to 15 veins/5 mm.), and these specimens have somewhat shorter leaf blades than the others; both specimens have the inflorescence typical of the species. The description of the fruit above is taken from *Kanehira* & *Hatusima* 13980.

139. *Calophyllum trachycaule* Lauterb. Bot. Jahrb. 58: 13. fig. 3. 1922; A. C. Smith, Jour. Arnold Arb. 22: 346. 1941; P. F. Stevens, Austral. Jour. Bot. 22: 405. 1974. TYPE: Nordost-Neu-Guinea [Papua New Guinea], Sepikgebiet, Augusta-Flussgebiet, Etappenberg, 850 m., 30 Oct. 1912, *Ledermann* 9572 (isotypes, K, L).

Tree 10–20 meters tall, d.b.h. to 52 cm.; spurs and buttresses absent; outer bark light or straw brown, with many shallow fissures, not peeling, the inner surface orange and greenish straw mottled; under bark deep red; inner bark red, with darker spots and lines in outer part; latex white, not sticky (*Stevens et al.* 910), or copious, yellowish, milky (*BW* 12877).

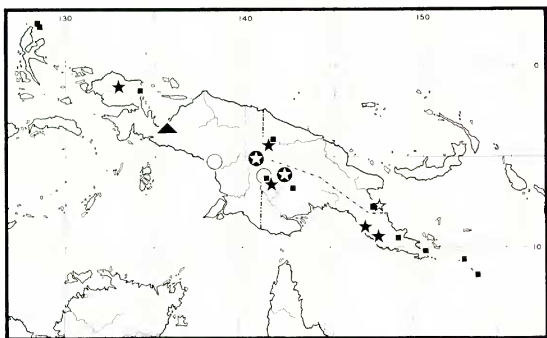
Twigs somewhat flattened, 1.8–3.5 mm. across, 4-angled or rounded, drying brown when young, often yellowish when older, (sub)persistently brown-tomentose; axillary innovations lacking basal scars; internodes (0.5–)1–6 cm. long; uppermost pair of axillary buds subrounded, 1.5–3(–5) mm. long, erect; terminal bud plump, 6–11 mm. long, with brown, tomentose indumentum (hairs, *FIGURE* 39, l, m), underdeveloped internode to 1.5 mm. long. Petiole 0.6–1.5 cm. long, narrowly to broadly concave above, convex below, persistently tomentose; lamina elliptic or oblong to subovate, (5–)7–14 by 1.5–4.5 cm., subacuminate to rounded at apex, rounded to cuneate or acute at base, obscurely undulate and slightly recurved at margin, coriaceous, drying umber to near sabelline above and near sabelline to sepia below,  $\pm$  persistently tomentose on midrib below (also above), the midrib above gradually narrowed from base, raised, 0.2–0.35 mm. wide at midpoint, below raised, slightly striate, angled toward base, the venation obscure on both surfaces (subapparent below), slightly raised, latex canals often depressed, 12 to 20 veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate or defoliate axils, with 7 to 19 flowers (with 3-flowered branches to 6 mm. long), the axis 0.8–3.7 cm. long, tomentose, lowest internode 3–6 mm. long; bracts unknown; pedicels 2.5–6 mm. long, tomentose. Flower (?)hermaphroditic; tepals 4, the outer pair ovate, 5–6 by 4–5 mm., the inner pair  $\pm$  elliptic, 6–8 by 4.5–6 mm.; stamens ca. 180, the filaments to 3.75 mm. long, the anthers elliptic, 0.5–0.7 mm. long, retuse at apex; ovary 1.5–2 mm. long, the style ca. 2.5 mm. long, the stigma peltate, ca. 1 mm. across, 4-radiate. Fruit ellipsoid, ca. 2.4 by 2 cm., rounded at apex, drying vinaceous, smooth; outer layer not detaching cleanly from stone, 2.2–3 mm. thick, compact apart from air spaces developing under skin; stone ellipsoid, ca. 1.8 by 1.2 cm., acute at apex, 3- or 4-angled, the walls 1.3–1.7 mm. thick, 2.3–2.8 mm. thick at angles and ca. 0.15 mm. thick just to one side of base, rather rough; spongy layer thin.

DISTRIBUTION. Occasional in New Guinea (*MAP* 44).

ADDITIONAL SPECIMENS SEEN. **Papuaia.** Irian Jaya. Vogelkop: N. slopes of Upper Aifat Valley, between Senopi and Aifatfeka, W. of Kebar Valley, 1050 m., *BW* 12877(?) (A (frag.), L, LAE). PAPUA NEW GUINEA. Western: Kiunga, 18 m., *Stevens et al.* 910 (A). Central: Kubuna, 100 m., *Brass* 5654 (A, BO, K, LAE, NY, US); Koitaki, 457 m., *Carr* 12887 (K, L, LAE, NY, SING).

ECOLOGY. Lowland or colline forest, 18–850 m. alt. Flowering in October; fruiting in November (fruit blue).

*Calophyllum trachycaule* can be recognized by the well-developed, tomentose indumentum that covers the inflorescence axis and pedicels (but not the tepals), stem, leaf midrib, and terminal bud; by its leaves, which have



MAP 44. Distribution of *Calophyllum goniocarpum* (squares), *C. trachycaule* (solid stars), *C. rufinerve* (triangle), *C. piluliferum* (circles), *C. heterophyllum* (stars in solid circles), and *Calophyllum* sp. 143 (open star) in Papuaia.

dense, obscure venation and impressed latex canals; by its short pedicels; and by its medium-sized fruits with angled stones. The epithet *trachycaule* means "rough stemmed," an allusion to the indumentum on the twigs.

*Calophyllum trachycaule* is closely related to *C. goniocarpum*; some differences between these and other related taxa are summarized in TABLE 17. All these taxa have leaf blades of a similar texture and color when dry, the margins are barely undulate and slightly revolute, and the venation is dense and somewhat obscure. Flowers are known from three taxa (*C. trachycaule*, *C. goniocarpum*, and *C. rufinerve*); all have four tepals. The outer layer of the fruit has a distinctive texture when dry: in young fruit it is compact, with a few prominent, but not dense, fibers; in fruit near maturity it is more or less disorganized by air spaces. In all taxa (except for *C. rufinerve*, fruit of which I have not seen) the stones are moderately to very strongly angled, the walls are often rough or pock marked, and there is a thin area just to one side of the base (FIGURE 6, c-e). Hairs in all taxa are similar, with thick-walled, often verruculose, basal cells and more or less thin-walled apical cells; there is usually a single basal branch, and the hairs are frequently completely birefringent. Plants of both *C. heterophyllum* and *C. goniocarpum* vary considerably in size.

The limits and number of the taxa in the *Calophyllum trachycaule* complex are difficult to judge. There is great variation in leaf shape and size and in general robustness of the plant (cf. FIGURE 38, a, and 38, c; see especially *C. goniocarpum*) and considerable variation in fruit size, superimposed on a general similarity in leaf type (which extends to anatomical details of the

TABLE 17. Variation of some characters in *Calophyllum trachycaule* and its relatives.

	<i>C. trachycaule</i>	<i>C. heterophyllum</i>	<i>C. rufinerve</i>	<i>C. goniocarpum</i>	<i>Calophyllum</i> sp. 143	<i>C. piluliferum</i>
TERMINAL BUD						
LENGTH (mm.)	6-11	6-10(-12)	5-11	5-14	2-4	4-6
INDUMENTUM	Tomentose	Crustaceous- subtomentose	Tomentose	Furfuraceous- short-tomentose	Subcrustaceous	± Subcrustaceous
LAMINA						
LENGTH (cm.)	(5-)7-14	4.5-9.5	6.8-12.5	(4.2-)6-23	2.2-5.2	4.3-8.8
APEX SHAPE	Subacuminate- rounded	Truncate- subacute	Acute	Subacuminate- retuse	Acute- subcuneate	Acute- bluntly acuminate
VEINS/5 mm.	12 to 20	6 to 11 (to 14)	12 to 16	9 to 17	10 to 14	12 to 22
INFLORESCENCE						
TERMINAL INTERNODE SHORTER THAN OTHERS	No	Yes	—	No	No	No
PEDICEL						
LENGTH (mm.)	2.5-6	4-16	Ca. 10	(0.35-)5-9 (-18 in fruit)	5-10	6-12
INDUMENTUM	Tomentose	None to sparse- puberulent	"Pilose"	None	None	None
FRUIT LENGTH (cm.)	Ca. 2.4	Ca. 1.2	Ca. 0.5	1.7-2.8	Ca. 0.8	Ca. 1.1

blade) and fruit structure. More intensive field work, together with knowledge of germination and seedling, may help to clarify the limits of the taxa involved; few collections with flowers are known. Around Kiunga (Western Province), *C. trachycaule* sensu stricto, the local form of *C. goniocarpum*, and what may be a form of *C. piluliferum* grow in close proximity in well-drained forest on ridges, while near Buso (Morobe Province), the local form of *C. goniocarpum* and *Calophyllum* sp. 143 apparently grow in the same general area.

Lamina shape variation in *Calophyllum trachycaule* has been discussed earlier (Stevens, *loc. cit.*). *BW 12877* and Stevens *et al.* 910 have blades that are more or less acute at the apex and base and so approach the type specimen; the specimens from the Central Province have suboblong blades that are more rounded at the apex and the base. *BW 12877* is also somewhat similar to the type (and only) specimen of *C. rufinerve* and is only provisionally included in *C. trachycaule*.

140. *Calophyllum heterophyllum* P. F. Stevens, Austral. Jour. Bot. **22**: 371. fig. 7. 1974. TYPE: Nederlands Nieuw-Guinea [Irian Jaya], Star Mts., Sibil-valley, 1200–1300 m., 26 May 1959, *Kalkman 4151* (holotype, LAE; ISOTYPES, A, BM, BO, CANB, L).

More or less prostrate shrub 1 meter tall to canopy tree 29 meters tall, d.b.h. to 35 cm.; trunk not buttressed; outer bark brown, smooth; latex yellowish, copious.

Twigs flattened, 2–3.5 mm. across, usually obscurely 4-angled, drying yellowish brown, brown-puberulent when young; axillary innovations lacking basal scars; internodes 1–3(–5) cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long, suberect; terminal bud plump, 0.6–1(–1.2) cm. long, with brown, crustaceous to puberulo-tomentose indumentum (hairs, FIGURE 39, d–f), underdeveloped internode to 1(–3.5) mm. long. Petiole 0.35–1.1 cm. long, concave above and convex below, subpersistently puberulent; lamina oblong, elliptic, ovate, or obovate, 4.5–9.5 by 2–4 cm., broadly truncate to subacute at apex, rounded to cuneate at base, obscurely undulate and flat to recurved at margin, coriaceous, drying dull brick to sepia above and umber to honey-sabelline below, subpersistently puberulent on midrib above, margin, and especially midrib below, the midrib above narrowing gradually to rather quickly near base, flat or subdepressed at first with margins raised, becoming raised, 0.25–0.3 mm. wide at midpoint, below raised, striate, the venation subobscure above and subobscure to apparent below, raised to depressed, 6 to 11 (to 14) veins/5 mm., angle of divergence 75–85°. Inflorescences from foliate axils along twigs, with (3 to) 5 to 11 flowers (sometimes flabellately arranged), unbranched (rarely with 3-flowered branches to 0.6 cm. long), the axis 1–3.2 cm. long, puberulent (?glabrous toward apex), lowest internode 0.2–1.3(–1.7) cm. long, uppermost internode often very much shorter than others, terminal five flowers appearing umbellate; bracts not known; pedicels 0.4–1.6 cm. long, glabrous or sparsely puberulent. Flower (?)her-

maphroditic; tepals 4 (rarely 5), the other pair broadly ovate, ca. 5.5 mm. by 3.5–4 mm., the inner pair elliptic-obovate, 6–7.5 by ca. 3.5 mm.; stamens 100 to 110, the filaments to 3 mm. long, the anthers oblong, ca. 1 mm. long, truncate to slightly retuse at apex; ovary ca. 1.1 mm. long, the style ca. 2.5 mm. long, the stigma excentrically peltate, 0.7–1 mm. across, 4-radiate. Immature fruit subspherical, ca. 1.2 by 1.2 cm., drying maroon, smooth; outer layer soon disorganized by air spaces; stone (?) angled.

DISTRIBUTION. Western New Guinea (MAP 44); little collected.

ADDITIONAL SPECIMENS SEEN. **Papuasias.** IRIAN JAYA. Vogelkop: N. slopes of upper Aifat Valley, between Senopi and Aifatfeka, W. of Kebar Valley, 810 m., *BW 12831* (?) (L). Snow Mountains: Star Mts., Sibil Valley, 1200–1300 m., *Kalkman 4554* (A, L, LAE, SING). PAPUA NEW GUINEA. Western: Palmer R., 3 km. below junction Black R., 100 m., *Brass 7385* (A, BO, L).

ECOLOGY. Variable: shrubs or treelets, in heathy vegetation developed over poor, white, badly drained loam, 1200–1300 m. alt. (Star Mts.); large tree in primary forest, 810 m. (Kebar Valley); canopy tree common on lower ridges, 100 m. alt. (Palmer R.).

*Calophyllum heterophyllum* can be recognized by its plump terminal bud and its medium-sized lamina with obscure venation, at least on the upper surface, and usually only 7 to 11 veins/5 mm. The terminal internode of the inflorescence is often notably shorter than the others, or even undeveloped, so there often appears to be a terminal umbel of five flowers. The flowers have four tepals, with the outer pair rather thick. The stone is possibly angled. The epithet *heterophyllum* was chosen because of the considerable variation in leaf size and shape occurring on a single specimen.

The delimitation and relationships of *Calophyllum heterophyllum* are unclear. *Brass 7385* was collected at much lower altitudes and from a much larger tree than the other specimens; it has immature fruits. The margin of the lamina is considerably more recurved than that of the other specimens, but the venation density and inflorescence are similar, and the specimen has a similar facies. The fruits are still very immature, but the center part (stone plus embryo) appears to be angled. This suggests a relationship of *C. heterophyllum* to the *C. trachycaule* complex, from which the venation density and inflorescence type most readily distinguish it (TABLE 17).

*BW 12831* has crustaceous indumentum on the terminal bud, and there are up to 13 veins/5 mm. *Brass 7099* (A, BO, K, L) was earlier cited as *Calophyllum* sp. B, aff. *C. heterophyllum* (Stevens, loc. cit.); it was collected in the same area as *Brass 7385*. It has elliptic-oblong leaf blades only 2.2–4.5 cm. long, and its immature fruits, which have dried spherical, smooth, and the same color as those of *Brass 7385*, are less than 8 mm. across. However, it is possibly to be included in *C. heterophyllum*. The field notes of *Brass 7099* mention a spurred trunk and thick, flaky, suberose bark. As with other members of the *C. trachycaule* complex, *C. heterophyllum* needs careful study in the field.

141. *Calophyllum rufinerve* Kanehira & Hatusima, Bot. Mag. Tokyo **56**: 563, fig. 4. 1942; P. F. Stevens, Austral. Jour. Bot. **22**: 409. 1974. TYPE: Dutch New Guinea [Irian Jaya], Dalman, 45 km. inward of Nabire, 400 m., 2 May 1940, Kanehira & Hatusima 12218 (isotype, A).

Tree 20 meters tall; bark unknown.

Twigs somewhat flattened, 1.5–2 mm. across, strongly 4-angled, drying brown when young, yellowish when older, subpersistently brown-tomentose; axillary innovations lacking basal scars; internodes 0.5–3 cm. long; uppermost pair of axillary buds rounded, to 2 mm. long, erect; terminal bud plump, 5–11 mm. long, with brown, tomentose indumentum (hairs, FIGURE 39, u, v), underdeveloped internode absent. Petiole 0.8–1.3 cm. long, deeply concave above, convex below, tomentose; lamina subovate to elliptic, 6.8–12.5 by 1.9–3.4 cm., acute at apex, cuneate to subrounded at base, obscurely undulate and slightly recurved at margin, coriaceous, drying fulvous-umber on both surfaces, subpersistently tomentose on midrib below, the midrib above gradually narrowed from base, raised, 0.2–0.35 mm. wide at midpoint, below raised, striate, the venation obscure above, subapparent below, slightly raised, latex canals  $\pm$  impressed, 12 to 16 veins/5 mm., angle of divergence 75–80°. Inflorescences from (?)defoliate axils,  $\pm$  fasciculate, with 1 to 3 flowers, axis absent; bracts unknown; pedicels ca. 1 cm. long, pilose. Tepals 4, glabrous, rounded-elliptic, ca. 2.5 mm. long; stamens ca. 25, ca. 1.2 mm. long; ovary ca. 1 mm. long, stigma dilated. Fruit spherical, ca. 5 mm. across.

DISTRIBUTION. Irian Jaya (MAP 44); known only from the type location.

ECOLOGY. *Agathis* forest, 400 m. alt. Flowering and fruiting in May; fruit black.

*Calophyllum rufinerve* is a very poorly known taxon that can be characterized by the tomentose indumentum on the terminal bud, twig, and midrib, the pilose pedicels, the fasciculate inflorescence, and the small, spherical fruits only about 5 mm. across. The epithet *rufinerve* means "reddish nerved," an appropriate name because of the reddish indumentum that persists on the midrib.

The fruits of *Calophyllum rufinerve* may have angled stones, but only *Calophyllum* sp. 143 of the *C. trachycaule* complex has fruits comparable in size to those of *C. rufinerve*, and that taxon has very much smaller leaves and a different inflorescence (see TABLE 17). Stevens (*loc. cit.*) suggested that *C. rufinerve* and *C. soulattri* were related, but the latter species often has glabrous pedicels, and its fruits are about twice as big.

The description of the flower and fruit above are taken from Kanehira and Hatusima's original description. They cite the date and altitude of collection of the type specimen as March 2 and 500 meters; on the isotype at the Arnold Arboretum, the date is given as May 2, and the altitude as 400 meters.

142. *Calophyllum goniocarpum* P. F. Stevens, Austral. Jour. Bot. **22**: 369, fig. 6. 1974. TYPE: Papua, Misima Island, Quartz Mountain, 150 m.,



8 Aug. 1956, *Brass* 27669 (holotype, LAE; isotypes, A, BO, K, L).

FIGURES 6, c-e; 38, a, b.

(Shrub or) tree, to 36 meters tall, d.b.h. to 60 cm.; buttresses and spurs absent; outer bark brown, gray-brown, pale yellowish brown, olive, or yellow-green, with long, shallow fissures or small lenticels, the inner surface yellowish straw; under bark brownish, yellow, or red with yellow on back; inner bark reddish; latex opaque yellow, not very sticky, to pale honey, sticky, or watery, resinous.

Twigs slightly flattened, 2-4.5 mm. across, usually rather strongly 4-angled, drying (dark) brown (yellowish when older), with brown,  $\pm$  transient to subpersistent, puberulent to short-tomentose indumentum; axillary innovations lacking basal scars; internodes 0.5-5(-7.5) cm. long; uppermost pair of axillary buds rounded, 1-4 mm. long, suberect to erect; terminal bud plump, 0.5-1.4 cm. long, with gray to brown, furfuraceous to short-tomentose indumentum (hairs, FIGURE 39, g-j; cf. 39, d), underdeveloped internode absent (-2.5 mm. long). Petiole 0.4-3 cm. long,  $\pm$  concave above, convex below, glabrescent; lamina obovate to oblong or elliptic, (4.2-)6-23 by (2-)2.5-9.5 cm., obscurely acuminate to retuse at apex, acute to cordate at base, distantly undulate and slightly recurved at margin, coriaceous, drying near bay or umber to near sabelline above to umber, honey, or sabelline below, soon glabrescent or subpersistently puberulent to subtomentose on midrib below, the midrib above  $\pm$  abruptly narrowing at base, becoming  $\pm$  raised, 0.2-0.5 mm. wide at midpoint (disappearing up to 5 mm. below apex), below raised, striate (weakly angled), the venation usually obscure on both surfaces, slightly raised, latex canals sometimes also raised, 9 to 17 veins/5 mm., angle of divergence 60-80°. Inflorescences from foliate axils, with 5 to 17 flowers (with 3-flowered branches to 1 cm. long), the axis 1-6 cm. long, puberulent to subtomentose at base (also elsewhere), lowest internode 0.3-3.6 cm. long; bracts ovate, to 5 mm. long, soon deciduous; pedicels (0.35-)0.5-0.9 cm. long, to 1.8 cm. long in fruit, glabrous. Flower (?)hermaphroditic; tepals 4 (rarely 5), the outer pair ovate, 4.5-5 by 3.5-4 mm., the inner pair elliptic-obovate, to 6 by 4 mm.; stamens 50 to 180, the filaments to 3 mm. long, the anthers oblong to elliptic, 0.5-2 mm. long, truncate to retuse at apex; ovary 1.2-1.5 mm. long, the style ca. 2.5 mm. long, the stigma peltate, ca. 0.7 mm. across, 3-radiate. Fruit ellipsoid to spherical, 1.7-2.8 by 1.2-2.6 cm., rounded at apex, drying pruinose- to vinaceous-brown, smooth; outer layer not detaching cleanly from stone, 1.5-5 mm. thick, air spaces often developing especially under skin; stone ellipsoid to subspherical, 1.4-2 by 0.8-2.6 cm., acute to obtuse at apex, (2- or) 3- or 4- (or 5-)angled, the walls 0.5-1.4 mm. thick, to 2 mm. thick in angles, ca. 0.3 mm. thick just to one side of base, rough or pock marked; spongy layer thin.

DISTRIBUTION. New Guinea and the Moluccas (MAP 44).

SELECTED SPECIMENS SEEN. **Moluccas.** MOROTAI: subdistr. Tobelo, N. Totodokoe, 40 m., *bb* 33914 (A, BO, BRI, K, L, LAE, NY, P, SING), 30 m., *bb* 33771 (A, BRI, K, LAE, SING). **Papuasias.** IRIAN JAYA. Vogelkop: Warnapi, N. of Ransiki

(80 km. S. of Manokwari), 10 m., *Kostermans* 4757 (BO, L). PAPUA NEW GUINEA. West Sepik: August R., *NGF* 3837 (?) (BO, CANB, K, L, LAE, SING). Morobe: Buso R., 5 m., *NGF* 24474 (A, CANB, LAE, M, SING), *Conn* 318 (A); Natter Bay logging area, 93 km. SE. of Lae, 100 m., *LAE* 68580 (A). Southern Highlands: Mt. Bosavi, No. side, near mission station, 700–800 m., *Jacobs* 8961 (L, LAE, US). Western: SW. corner of airstrip, Kiunga, *NGF* 18312 (A, CANB, L, LAE, M, MO). Milne Bay: Mayu Is., junction of Mayu and Ugat rivers, 330 m., *LAE* 56132 (A, CANB, E, K, L, LAE, M, MO, US); about half way along the N. shore of Milne Bay, *NGF* 1387 (?) (E, L, LAE, SING). Papuan Islands: Tagula Is., Mt. Riu, 700 m., *Brass* 27842 (A, K, L, LAE, US), Rambuso, 150 m., *Brass* 28042 (A, K, L, LAE, US).

**ECOLOGY.** Well-drained, often colline forest, rarely swamp forest (*Kostermans* 4757); 10–800 m. alt. Flowering in August; fruiting March, April, July, August, and October (fruit bluish to blackish, sometimes apparently dull green (*LAE* 68580)).

*Calophyllum goniocarpum* can be recognized by its plump terminal buds, its usually only moderately well-developed indumentum, its medium-sized to large leaf blades with fine, often rather dense venation, its inflorescence axis at least 1 cm. long, and its fruits with angled stones. The epithet *goniocarpum* was chosen because of this last characteristic.

Some of the characters by which *Calophyllum goniocarpum* can be distinguished from other members of the *C. trachycaule* complex are given in TABLE 17. *Calophyllum goniocarpum* is a large-fruited member of the complex and lacks very well developed indumentum.

There is considerable variation in the specimens assigned to *Calophyllum goniocarpum*. Variation in floral characters is poorly known; however, it may be noted that specimens from the Moluccas and the Vogelkop Peninsula (clearly more similar to one another than to any other specimens with angled stones) have flowers with 140 to 180 stamens, while those from the Papuan Islands have 50 to 80. Specimens from around Kiunga have stones that are subspherical in transverse section, the angles being poorly marked; elsewhere in the range of the species, the stones are almost triangular or square in cross section. *NGF* 1387, from the Milne Bay area, has rounded twigs ca. 1.3 mm. across that dry yellowish, the terminal bud is as short as 3.5 mm., and the lamina is as little as 4.3 cm. long. Although probably belonging to a taxon with angled stones, *NGF* 1387 is included here mainly for convenience; it has not been included in the description.

Possible confusion between *Calophyllum brassii* and *C. goniocarpum* is discussed under *C. brassii*.

#### 143. *Calophyllum* sp.

FIGURE 38, c, d.

Tree 6–10 meters tall, d.b.h. to 10 cm.; trunk without buttresses; outer bark grayish brown, fissured, the inner surface orange-yellow; under bark orange-reddish; inner bark reddish; latex yellow.

Twigs flattened, 0.7–1.3(–2) mm. across,  $\pm$  4-angled, drying dark brown when young, yellowish brown when old, transiently subfarinose; axillary

innovations lacking basal scars; internodes 0.5–1.5(–3) mm. long; uppermost pair of axillary buds rounded, to 1 mm. long, erect; terminal bud plump, 2–4 mm. long, with brown, adpressed, subcrustaceous indumentum (hairs, FIGURE 39, n), underdeveloped internode absent. Petiole 4–9 mm. long, strongly concave above, convex below, glabrous; lamina elliptic, 2.2–5.2 by 0.5–1.5 cm., acute to subcuneate at apex, cuneate at base, not undulate but slightly recurved at margin, coriaceous, drying umber above and sabelline below, with transient, adpressed indumentum on midrib below (also above), the midrib above gradually narrowed from base, raised, 0.1–0.15 mm. wide at midpoint, below raised, striate or subangled, the venation subobscure above, subapparent below, raised, 10 to 14 veins/5 mm., angle of divergence ca. 65°. Old inflorescences from foliate (rarely defoliate) axils, with 3 to 7 flowers, unbranched, the axis 0.5–1.8 cm. long, puberulent toward base, lowest internode 2–4 mm. long; bracts not known; pedicels 5–10 mm. long, glabrous. Flower not known. Fruit spherical, about 8 by 8 mm., drying purplish brown, smooth; outer layer not separating cleanly from stone, thin, air spaces developing; stone subspherical, ca. 6 by 6 mm.,  $\pm$  rounded at apex, 3- (rarely 2-)angled, the walls 0.2–0.25 mm. thick, to 0.5 mm. thick in angles,  $\pm$  smooth; spongy layer thin.

DISTRIBUTION. Known only from Papua New Guinea (MAP 44).

SPECIMENS SEEN. **Papuasias.** PAPUA NEW GUINEA. Morobe: Mt. Kawea, Buso, 800 m., NGF 24444 (A, CANB, E, K, L, LAE, M, SING), 600 m., LAE 52306 (L, LAE).

ECOLOGY. Rather stunted forest on soil derived from ultramafic rock, 600–800 m. alt. Fruiting in April; fruit blackish.

*Calophyllum* sp. 143 can be distinguished from the other taxa known to have angled stones by its short terminal buds, small, elliptic leaf blades, and very small fruits (see TABLE 17). The fruits seen (from LAE 52306) were probably ripe, to judge by both their color and the fact that the embryo filled the stone. Unfortunately, they did not germinate.

144. *Calophyllum piluliferum* P. F. Stevens, Austral. Jour. Bot. 22: 387. fig. 11. 1974. TYPE: Papua New Guinea, Western District, Kiunga, 45 m., 8 Aug. 1971, LAE 51772 coll. Streimann & Katik (holotype, LAE; isotypes, A, CANB, L, SING).

Tree ca. 18 meters tall, d.b.h. ca. 23 cm.; trunk without buttresses, but pneumatophores perhaps present (Pullen 7531); outer bark light gray, slightly vertically cracked, with few pustules; under bark reddish; inner bark paler red; latex yellow.

Twigs flattened, 1–1.5 mm. across, obscurely 4-angled, drying brown when young, yellowish or whitish brown when older, transiently farinose-puberulent; axillary innovations lacking basal scars; internodes 0.5–3 cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long,  $\pm$  erect; terminal bud plump, 4–6 mm. long, with brown,  $\pm$  subcrustaceous indumentum (hairs, FIGURE

43, a, b), underdeveloped internode to 1 mm. long. Petiole 0.6–1.2 cm. long, shallowly concave above, convex below, glabrescent, drying blackish; lamina elliptic to suboblong, 4.3–8.8 by 1.4–3.2 cm., acute to bluntly acuminate at apex, attenuate at base, barely undulate but slightly recurved at margin, coriaceous, drying sabelline on both surfaces,  $\pm$  transiently farinose-puberulent on midrib below, the midrib above gradually narrowed from base, raised, 0.1–0.2 mm. wide at midpoint (disappearing just below apex), below raised, striate, venation obscure to apparent, the latter especially below, raised, 12 to 22 veins/5 mm., angle of divergence 65–75°. Infructescences from foliate axils, with scars of 3 to 11 flowers, rarely branched, the axis 0.15–1.6 cm. long, glabrous, lowest internode 2–4 mm. long; bracts unknown; pedicels 0.6–1.2 cm. long, glabrous. Flower unknown; few stamens persisting at base of fruit, the filaments to 2 mm. long, the anthers oblong, ca. 0.5 mm., retuse at apex. Fruit spherical, ca. 1.1 by 1.1 cm., rounded at apex, drying pruinose-brown, smooth; outer layer not detaching cleanly from stone, ca. 0.5 mm. thick, with large air spaces developing; stone ellipsoid, ca. 9.5 by 7.5 mm., obtuse at apex, 3- or 4-angled, the walls ca. 0.4 mm. thick, to 1 mm. thick in angles,  $\pm$  smooth; spongy layer thin.

DISTRIBUTION. Southern New Guinea (MAP 44).

ADDITIONAL SPECIMENS SEEN. **Papuasias**. IRIAN JAYA. Digul: Asmat region, Erma, 0 m., *BW 6577* (L). PAPUA NEW GUINEA. Western: Upper Fly R. along the Binge R., 10 m. *Pullen 7531* (CANB).

ECOLOGY. Forest in or near swamps, to 40 m. alt. Fruiting in August; fruit blackish red.

*Calophyllum piluliferum* can be recognized by its rather small leaves that are acute to bluntly acuminate at the apex and attenuate at the base, and by its fairly small, spherical fruits with angled stones. Older twigs dry pale brown. The epithet *piluliferum* was chosen because the round fruits are like small balls (*pilus*, Latin "ball").

*Calophyllum piluliferum* is related to *C. trachycaule*; some characters by which it can be differentiated from this and related taxa are given in TABLE 17.

The leaf blades of *BW 6577* are somewhat thin, and their venation is notably prominent; however, it seems that the specimen was collected soon after a flush of growth.

There are three collections from **Papuasias** in which the leaf base is so narrowly attenuate that the petiole appears to be much longer than it actually is (cf. also *Calophyllum venulosum* var. *tenuivenium*); they are perhaps close to *C. piluliferum*. *Stevens et al.* 913 was also collected at Kiunga, but its pale yellow-drying twigs are about 2 mm. across, and the lamina is apparently 11.5 by 3.4 cm., with the "petiole" ca. 2 cm. long. Two collections from Japen Island, Irian Jaya (*bb 30480* (A, L, SING) and *bb 30481* (A, L)), have a similarly long "petiole" but differ in facies; the lamina of *bb 30481* is up to 22 by 4.3 cm. More collections are needed to assess the status of these collections.

145. *Calophyllum streimannii* P. F. Stevens, Austral. Jour. Bot. 22: 401. fig. 14. 1974. TYPE: Papua New Guinea, Morobe District, 24 km. SW. of Morobe on the Mo River, 300 m., 28 Jan. 1972, NGF 24285 coll. *Streimann* (holotype, LAE; isotypes, A, CANB, K, L, SING).

Tree 15–35 meters tall, d.b.h. ca. 30 cm.; trunk without buttresses; outer bark yellowish to dark gray, with longitudinal fissures; under bark reddish; inner bark cream; latex yellow.

Twigs slightly flattened, 2–4 mm. across,  $\pm$  strongly 4-angled, drying dark brown, transiently farinose to subpersistently puberulo-tomentose; axillary innovations lacking basal scars; internodes 0.5–5 cm. long; uppermost pair of axillary buds rounded, to 2 mm. long, suberect, not very conspicuous; terminal bud plump, 5.5–10 mm. long, with crustaceous to puberulo-tomentose indumentum (hairs, FIGURE 39, q, r, t), underdeveloped internode to 1 mm. long. Petiole (0.4–)1.5–2.5 cm. long, concave above, convex below, glabrous or subpersistently puberulent; lamina suboblong to elliptic or subobovate, 5.2–14 by 2.2–6 cm., acuminate to subacute at apex, acute to attenuate at base, rather distantly undulate and sharply recurved at margin, coriaceous, drying sabelline- to hazel-olivaceous above and fulvous-umber to sepia below, glabrescent or with subpersistent indumentum on midrib below, the midrib above narrowing gradually from base, becoming  $\pm$  raised, surrounding blade raised or not, 0.3–0.5 mm. wide at midpoint, below raised,  $\pm$  angled, the venation above subobscure to apparent, below apparent, raised, 6 to 10 veins/5 mm., angle of divergence 65–80°. Infructescences from foliate axils, with the scars of 7 flowers, unbranched, the axis ca. 2 cm. long, persistently puberulent to subtomentose, at least toward base, lowest internode 0.7–1 cm. long; bracts unknown; pedicels ca. 6 mm. long, (?)glabrous. Flower known only in bud, (?)hermaphroditic; tepals 8; stamens ca. 80, the anthers oblong, ca. 1.3 mm. long, acuminate at apex. Fruit ovoid to ellipsoid, 3.6–5 by 2.8–3.8 cm., pointed at apex, drying dark brown, smooth; outer layer detaching cleanly from stone or not, 4–5 mm. thick, compact; stone ovoid, ca. 2.5 by 1.9 cm., obtuse at apex, the walls 1–1.75 mm. thick, 3 mm. thick at base, smooth, unmarked, with basal plug ca. 8 mm. across; spongy layer thin.

DISTRIBUTION. Morobe Province, Papua New Guinea (MAP 40).

SELECTED SPECIMEN SEEN. **Papuasiasia.** PAPUA NEW GUINEA. Morobe: Buso, 30 m., LAE 52755 (A, CANB, K, L, LAE).

ECOLOGY. Ridges or hillsides, often with dipterocarps, 30–300 m. alt. Fruiting in January; fruit blue.

GERMINATION AND YOUNG PLANT. The radicle pushes out a plug from the base of the stone. The seedling has two pairs of leaves separated by an internode of ca. 1 cm. Subsequently produced internodes are longer, the terminal bud is functional, and the plant is erect. (NGF 24285, 24491.)

*Calophyllum streimannii* can be recognized by its suboblong to elliptic, medium-sized to rather large leaf blades that are acuminate at the apex,

somewhat sharply recurved at the margin, and with only 6 to 10 veins/5 mm. The fruit is large (3.6–5 cm. long) and is pointed at the apex; the outer layer is thick (4–5 mm.), and the stone has a basal plug. The epithet commemorates the collector, H. Streimann.

*Calophyllum streimannii* is a rather heterogeneous taxon. NGF 28084 is included with hesitation; it differs in a number of details from the other specimens (see Stevens, *loc. cit.*); the details of the flower bud in the description above are taken from this specimen.

*Calophyllum streimannii* may also occur in the Western Province (Foreman s.n., LAE sheet 129036, 8 km. N. of Kiunga on road to Rumingae, 30 m. (LAE)).

*Calophyllum streimannii* is perhaps close to *C. morobense*, but it has larger leaves with more distant venation and fruits about twice as large that dry smooth rather than sharply wrinkled. The hairs of the two species are fairly similar (cf. FIGURE 39, q, r, t, and 39, k, s).

146. *Calophyllum morobense* P. F. Stevens, Austral. Jour. Bot. **22**: 378. fig. 9. 1974 ("C. morobensis"). TYPE: Papua New Guinea, Morobe District, Sunkwep road, 220 feet [65 m.], 19 April 1971, NGF 46766 coll. Katik (holotype, LAE; isotypes, A, CANB, E, G, K, M, SING).

Tree to 21 meters tall, d.b.h. to 30 cm.; trunk without buttresses or spurs; outer bark dull greenish with slightly raised, elongated orange patches, or light gray, with shallow, boat-shaped fissures, the inner surface dull orange; under bark dull dark red; inner bark cream to reddish; latex whitish near outer bark, brownish near wood, or yellow (NGF 24490). Branching horizontal, crown open.

Twigs flattened, ca. 1.5 mm. across, 4-angled, drying dark brown, sparsely puberulent when young; axillary innovations lacking basal scars; internodes 1–3.5(–7.5) cm. long; uppermost pair of axillary buds rounded, ca. 0.5 mm. long, spreading, inconspicuous; terminal bud plump to narrowly conical, 2.5–5 mm. long, with brown indumentum (hairs, FIGURE 39, k, s), underdeveloped internode absent. Petiole 0.6–1 cm. long, concave above, convex below, glabrous at maturity; lamina elliptic to ovate or suboblong, 4.5–9 by 2–4.5 cm., acuminate at apex, acute to cuneate at base, slightly undulate and not recurved or slightly so at margin, coriaceous, drying bay to cinnamon above and bay to umber below, glabrous at maturity, the midrib above gradually narrowed from base,  $\pm$  depressed at first, eventually becoming slightly raised, 0.1–0.2(–0.3) mm. wide at midpoint, below slightly raised, striate, the venation subobscure to apparent on both surfaces, slightly raised or not, latex canals sometimes impressed, 13 to 16 veins/5 mm., angle of divergence 75–80(–85)°. Infructescences from foliate axils, with scars of 7 flowers, unbranched, the axis 1–1.5 cm. long, glabrous, lowest internode ca. 3 mm. long; bracts unknown; pedicels 5–7 mm. long, glabrous. Flower unknown. Fruit ovoid to subspherical, ca. 2.8 by 2.2–2.8 cm., acute at apex, drying brown, sharply and closely wrinkled; outer layer detaching cleanly from stone or not, 2–3.5 mm. thick, compact; stone ovoid to ellipsoid, 2.2–2.7 by 1.8–1.9 cm.,  $\pm$  obtuse at apex,

the walls 1.3–1.5 mm. thick, smooth apart from shallow, elongated pock marks, probably with basal plug ca. 6 mm. across; spongy layer thin.

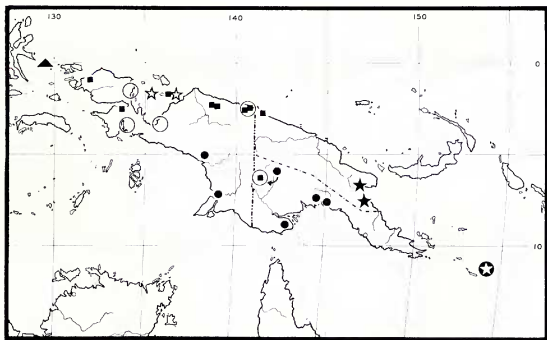
DISTRIBUTION. Morobe Province, Papua New Guinea (MAP 45).

SELECTED SPECIMEN SEEN. **Papuasias**. PAPUA NEW GUINEA. Morobe: near Buso Village, 5 m., NGF 24490 (A, CANB, E, K, LAE, M, SING).

ECOLOGY. Alluvium in lowland rainforest, 5–35 m. alt. Fruiting in April; fruit bluish to almost black.

*Calophyllum morobense* can be recognized by its medium-sized, strongly acuminate leaf blades with a relatively inconspicuous midrib on both surfaces and fairly dense venation (13 to 16 veins/5 mm.). The fruits are relatively large, more or less acute at the apex, and dry strongly wrinkled; the stone walls are 1.2–1.5 mm. thick. Plants referable to this taxon have been collected only from Morobe Province, Papua New Guinea—hence the epithet.

It was earlier thought (Stevens, *loc. cit.*) that *Calophyllum morobense* was similar in leaf to *C. pulcherrimum* and *C. floribundum* (= *C. tetrapterum*); however, the midrib on the upper surface of the lamina is not surrounded by raised blade as in *C. pulcherrimum*, nor is it sharply raised as is usual in *C. tetrapterum*. *Calophyllum morobense* does not seem to be particularly closely related to these or any other West Malesian species but is most similar to *C. streimannii*. For the differences separating these species, see *C. streimannii*.



MAP 45. Distribution of *Calophyllum macrophyllum* (triangle), *C. persimile* (squares), *C. novoguineense* (open circles), *C. suberosum* (solid circles), *C. morobense* (solid stars), *C. insularum* (open stars), and *C. acutiputamen* (star in solid circle) in Papuasias.

147. *Calophyllum acutiputamen* P. F. Stevens, Austral. Jour. Bot. **22**: 359. *fig. 1*. 1974. TYPE: Papua, Rossel Island, Abaleti, 300 m., 5 Oct. 1956, Brass 28325 (holotype, LAE; isotypes, A, BO, K, L, US).

(?) Large tree; bark unknown; latex reported to be "not milky."

Twigs slightly flattened, 2–2.5 mm. across, 4-angled and with two additional raised lines, drying dark brown, with subadpressed indumentum when young; axillary innovations lacking basal scars; internodes 0.5–3(–5.5) cm. long; uppermost pair of axillary buds  $\pm$  pointed, ca. 1 mm. long, erect and adpressed to terminal bud; terminal bud conical, 7–9 mm. long, with subadpressed, brown indumentum (hairs, FIGURE 43, c, d), underdeveloped internode to 1 mm. long. Petiole 0.7–1.2 cm. long, narrowly channeled above, angled below,  $\pm$  glabrous when mature; lamina elliptic to subobovate, 5.5–8 by 1.5–2.4 cm., acute at apex, cuneate at base, not undulate and not recurved to slightly so at margin, very coriaceous, drying cinnamon-sepia above and cinnamon below, subpersistently puberulent on midrib below, the midrib above narrowed gradually from base, raised, 0.3–0.35 mm. wide at midpoint, below raised, angled, the venation on both surfaces obscure, slightly raised, 9 to 11 (to 13) veins/5 mm., angle of divergence 55–60°. Infructescences from foliate axils, with scars of 3 to 5 flowers, unbranched, the axis 0.5–1 cm. long, with sparse, subadpressed hairs, lowest internode ca. 4 mm. long; bracts unknown; pedicels 5–6 by 3 mm., sparsely puberulent. Flower unknown. Fruit ellipsoid, 4–4.3 cm. by 2.6–2.8 cm.,  $\pm$  apiculate, drying brown, with shallow, longitudinal corrugations; outer layer not detaching cleanly from stone, ca. 3.5 mm. thick, with large air spaces developing; stone ellipsoid to subobovoid, ca. 3.5 by 1.5 cm., acute at apex, the walls 0.8–1.2 mm. thick, thinner to one side of base,  $\pm$  smooth, unmarked; spongy layer thin.

DISTRIBUTION. Papuasias; known only from the type collection from Rossel Island (MAP 45).

ECOLOGY. Canopy tree on ridges in colline forest, ca. 300 m. alt. Submature fruit in October.

*Calophyllum acutiputamen* can be recognized by its more or less conical terminal bud; its unbranched, simple hairs; its elliptic, flat-drying leaves with obscure venation; and its relatively large (ca. 4 cm. long), ellipsoid fruits. The outer layer of the fruit is almost disorganized by air spaces although the skin is practically smooth; the stone is very sharply pointed at the apex. This latter feature suggested the specific epithet (*acutiputamen* means "pointed stone").

148. *Calophyllum suberosum* P. F. Stevens, Austral. Jour. Bot. **22**: 403. *fig. 15*. 1974, *pro parte*. TYPE: Papua New Guinea, Western District, Oriomo River, 70 feet [21 m.], 19 Jan. 1959, NGF 10410 coll. White & Gray (holotype, LAE; isotypes, A, BO, BRI, CANB, K, L, SING).

*C. peekelii* auct., non Lauterb.; T. C. Whitmore, Gard. Bull. Singapore **22**: 11. 1967, *pro parte*.



Tree 15–35 meters tall, d.b.h. to 60 cm.; trunk with stilt roots to 2 meters tall; outer bark (yellowish) gray-brown, deeply fissured, with flakes or scales, the inner surface straw brown; under bark pale reddish brown; inner bark pale reddish brown; latex clear yellow, very sticky.

Twigs flattened, 5–7(–9) mm. across, 4- or obscurely 6-angled, with obscure transverse lines at nodes, drying yellowish, sparsely brown-farinoso when young; axillary innovations lacking basal scars; internodes 1–7.5 cm. long; uppermost pair of axillary buds acute (rounded), 2–5 mm. long,  $\pm$  erect; terminal bud narrowly conical, 0.8–1.3 cm. long, with brown, crustaceous to subfurfuraceous indumentum (hairs, FIGURE 39, o; also moruloid), underdeveloped internode to 2 mm. long. Petiole 2–3.3 cm. long, broadly concave above, convex below, glabrous when mature; lamina ovate to elliptic, 16–35 by 7.5–14.2 cm., acute to rounded at apex, broadly rounded and finally acute at base, undulate and slightly recurved at margin, coriaceous, drying umber to sabelline-olivaceous above and near sabelline below, transiently brown-farinoso on midrib below, the midrib above gradually narrowed from base, raised, surrounding blade raised, 0.4–0.7 mm. wide at midpoint, below strongly raised,  $\pm$  angled, the venation apparent above and especially below, raised, latex canals sometimes also raised, 5 to 8 (or 9) veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils, with scars of 3 to 5 flowers, unbranched, the axis 1.5–2.8 cm. long, farinoso at least toward base, lowest internode 1–1.5 cm. long; bracts unknown; pedicels in fruit 1.5–3 cm. by 6 mm., glabrous. Flower unknown. Fruit in spirit spherical to ovoid, 8–9.5 by 7–8 cm., rounded to very obtusely pointed at apex, with broad, longitudinal ridges; outer layer not detaching cleanly from stone, 4–7 mm. thick, compact; stone spherical, 6–7 by 6–7 cm., rounded at apex, the walls ca. 0.7 mm. thick, smooth, (?)unmarked; spongy layer ca. 2 cm. thick.

DISTRIBUTION. Southern New Guinea (MAP 45).

ADDITIONAL SPECIMENS SEEN. **Papuasias.** IRIAN JAYA. Mimika: Asmat subdistr., Erma, *BW* 3231 (CANB, L), 6501 (L), 6504 (L), 6547 (L). Digul: along R. Digoel, near Koeweh, 5 m., *BW* 4839 (L). PAPUA NEW GUINEA. Western: Kiunga, Tuidemasuk Road, *NGF* 18335 (A, CANB, L, LAE), near airstrip, *Stevens et al.* 780 (A); Fly R., *d'Albertis s.n.*, anno 1877 (*herb. Becc.* 1144) (FI); 32 km. from mouth of Oriomo R., 45 m., *NGF* 37159 (A, L, LAE, SING); near Oriomo Station, 20 m., *LAE* 60418 (A, L, LAE). Gulf: Kikori R., *NGF* 4551 (A, BO, E, K, L, LAE, SING); Purari R. near Ravi Kawai, *Pullen* 6466 (CANB), *Craven & Schodde* 832 (A, CANB, L, LAE).

ECOLOGY. Swamp forest; river banks sometimes subject to tidal influence; below 45 m. alt. Fruiting January, March, and November (fruit green, embryo bright purple (*NGF* 10410; pers. obs.); fruit floats in water (*NGF* 37159) and may be dispersed by rivers).

GERMINATION AND YOUNG PLANT. The radicle breaks the stone just to one side of the base. The seedling has three, or sometimes two, pairs of leaves separated by internodes 4–17 cm. long; the lowest pair may fall off before the others. Subsequently produced internodes are also long, the terminal bud is functional, and the plant is erect. (*NGF* 18335, *Stevens et al.* 780.)

*Calophyllum suberosum* is a distinctive species that can be recognized by its large, ovate, coriaceous leaf blades in which the midrib on the upper surface is surrounded by raised blade. The very large fruits and the yellow-drying twigs are also characteristic. The epithet *suberosum* ("corky") was chosen because the fruit has a well-developed spongy layer and is apparently able to float.

*Calophyllum suberosum* is superficially similar to *C. persimile*; specimens of the two species were included in the original description of *C. suberosum*. The differences between the two species are discussed under *C. persimile* and listed in TABLE 18.

149. *Calophyllum persimile* P. F. Stevens, sp. nov.

FIGURE 40, k.

*C. suberosum* P. F. Stevens, Austral. Jour. Bot. 22: 403. 1974, *pro parte*.  
*Calophyllum* sp. C, P. F. Stevens, Austral. Jour. Bot. 22: 395. 1974.

A *Calophyllum suberosum*, quo ut videtur simili est, in lamina angustiore elliptica-oblonga percrassa apice retusa vel obtusa basi plerumque acuta, trunco radicebus grilliformibus haud proviso, et latice opaco, differt.

Tree 20–25 meters tall, d.b.h. to 40 cm.; trunk sometimes with small buttresses; outer bark yellow, or gray, red-brown, and yellowish mottled, or pale brown (rarely brownish black), fissured (scaly), the inner surface bright yellow (brownish under fissures); under bark red-brown or red and pale red mottled; inner bark red to cream; latex yellow, opaque, slightly viscous or not.

Twigs slightly flattened, [1.5–]3–6.5 mm. across, strongly 4-angled to subulate, or 6-angled, with obscure transverse lines at nodes, drying brown and shiny when young, later yellowish, transiently and sparsely brown-farinose; axillary innovations lacking basal scars; internodes 1–7.5(–9) cm. long; uppermost pair of axillary buds subacute, [1–]2.5–3.5 mm. long, erect; terminal bud plump to conical, [4–]7–9 mm. long, with brown, crustaceous to furfuraceous indumentum (hairs, FIGURE 39, p; cf. 39, o; also moruloid), underdeveloped internode to 2 mm. long. Petiole [1–]1.6–3.7 cm. long, shallowly concave to flat above and concave below, glabrous; lamina elliptic to oblong (rarely subovate), [5–]10–30 by [2.5–]3.5–9(–11.3) cm., retuse to rounded (rarely obtuse) at apex, acute to decurrent (rarely broadly rounded and ultimately acute) at base, slightly and distantly undulate and not recurved to slightly so at margin, very coriaceous, drying sepia to umber above and sepia-umber to sabelline below, sparsely subfarinose on midrib below, the midrib above gradually narrowed from base, raised, surrounding blade raised, 0.3–0.8 mm. across at midpoint, below raised, rounded to angled, the venation subapparent on both surfaces, raised, 4 to 10 veins/5 mm., angle of divergence [50–]65–80°. Inflorescences from foliate axils, with ca. 5 flowers, unbranched, the axis 1–2.1 cm. long, farinose toward base, lowest internode 0.4–1.3 cm. long; bracts ovate, 5–6.5 mm. long, farinose-puberulent beneath, subpersistent; pedicels 3–8 mm. long, glabrous. Flower (?) hermaphroditic; tepals 4, glabrous, the outer pair suborbicular, ca. 5 by 6 mm., the inner pair suboblong to

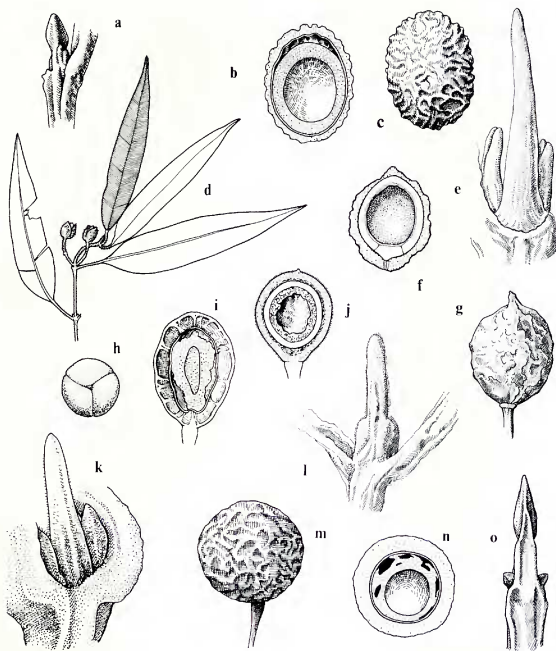


FIGURE 40. a-c, *Calophyllum rugosum*. a, Poilane 3494, terminal bud,  $\times 3$ . b, c, Poilane 30978, fruit,  $\times 1$ : b, longitudinal section; c, from outside. d, *C. insularum* (bb 30941), habit,  $\times 0.5$ . e-g, *C. leleanii*. e, NGF 6607, terminal bud,  $\times 3$ . f, g, Brass 3477, fruit,  $\times 1$ : f, longitudinal section; g, from outside. h, j, *C. molle* (KEP 77929), fruit,  $\times 0.75$ : h, stone, from apex; j, entire fruit, longitudinal section. i, *C. rubiginosum* (FRI 8709), fruit, longitudinal section,  $\times 1$ . k, *C. persimile* (NGF 18303), terminal bud,  $\times 3$ . l, *Calophyllum* sp. 151 (Stevens et al. 46), terminal bud,  $\times 6$ . m-o, *Calophyllum* sp. 163 (S 19958). m, n, fruit,  $\times 1.5$ : m, from outside; n, transverse section. o, terminal bud,  $\times 3$ .

suborbicular, ca. 9 by 8 mm.; stamens ca. 90, the filaments to 3 mm. long, the anthers oblong, 2–2.5 mm. long, acute at apex; ovary ca. 2.5 mm. long, the style ca. 2.5 mm. long, the stigma peltate, 3.5–5 mm. across, 3-radiate. Immature fruit ovoid, ca. 3 by 2.2 cm., smooth; outer layer ca. 3 mm. thick; stone not known.

TYPE: Papua New Guinea, Western District, SW. corner of Airstrip, Kiunga, 25 m., 15 Sept. 1972, *NGF 18303* coll. *Streimann & Lelean* (holotype, A; isotypes, E, CANB, K, L, LAE, M, MO, SING).

DISTRIBUTION. Western Papuasias (MAP 45).

ADDITIONAL SPECIMENS SEEN (\* denotes specimen with leaf anatomy examined). **PAPUASIA.** IRIAN JAYA. Vogelkop: Warsamson Valley, E. of Sorong, 50 m., *BW 12327* (L, LAE\*). Geelvink Bay: Japen Is., Aisaoe, bivouac Sebosari, 210 m., *BW 9229* (CANB, L, LAE\*), 180 m., *BW 10007* (L, LAE\*), 200 m., *BW 10539* (L, SING), 200 m., *BW 10547* (L, LAE\*). Djajapura: Bodem R., 60 km. SE. of Sarmi, 70 m., *BW 8092* (L\*, LAE, CANB); Kwansem R., 200 km. W. of Hollandia, 138 m., *BW 2378* (L, LAE\*, SING); Cycloop Mts., So. slope of Makanoi Range, W. of Kujabu R., 560 m., *van Royen & Sleumer 6561* (A\*, CANB, L, LAE); Hollandia, 50 m., *bb 25081* (A\*, BO, L), *Kostermans & Soegeng 287* (K\*, L). Fak-Fak: Anakasi (Babu), 50 m., *bb 32697* (L). PAPUA NEW GUINEA. West Sepik: Vaimo, 30 m., *LAE 52952* (LAE\*), 30 m., *LAE 53835* (L, LAE), *UTA 2184* (LAE). Western: Rumginae Road, 8 km. from Kiunga, 45 m., *Stevens et al. 808* (A\*), 45 m., *Stevens et al. 809* (A\*), 12 km. from Kiunga, 30 m., *Stevens et al. 843* (A\*).

ECOLOGY. Well-drained rain forest (Papua New Guinea); moist valleys, or rain forest inundated in wet season (Irian Jaya); 20–560 m. alt. Flowering in September.

*Van Royen & Sleumer 6561* has rather irregular spherical galls ca. 2.5 mm. across (the center is raised) near the midrib on the lower surface of the lamina; in *Kostermans & Soegeng 287* similar galls occur near the midrib and the margin.

GERMINATION AND YOUNG PLANT. The seedling has (two or) three pairs of leaves separated by internodes 1–2.5 cm. long. Subsequently produced internodes are less than 4 cm. long, the young plant is arched, the leaves are held in one plane, and the terminal bud is functional; the stem straightens later. In older plants the internodes are considerably more than 4 cm. long. (*Stevens et al. 809.*)

*Calophyllum persimile* can be recognized by its usually strongly four-angled twigs; its large, very coriaceous, usually elliptic to oblong leaf blades with the midrib on the upper surface surrounded by raised lamina; and its four-lobed flowers. The young plant does not grow very fast, and the stem is initially arched. The epithet *persimile* ("very similar") was chosen because of the considerable similarity of dried specimens of this species to those of *C. suberosum*.

When I described *Calophyllum suberosum*, I included in it specimens of the species here described as *C. persimile*. However, I found plants of two

TABLE 18. Differences between *Calophyllum suberosum* and *C. persimile*.

	<i>Calophyllum suberosum</i> *	<i>Calophyllum persimile</i> †
STILT ROOTS‡	Large	Lacking or very small
COLOR OF OUTER BARK AND ITS INNER SURFACE‡	Grayish or brownish	Often yellowish or bright yellow
LATEX‡	Clear yellow, sticky	Opaque yellow, ± fluid
LAMINA		
SHAPE	Ovate to elliptic	Elliptic to oblong (rarely subovate)
TEXTURE	Coriaceous	Very coriaceous
LENGTH : BREADTH RATIO	2-2.5	(2-)2.5-3
UPPER EPIDERMIS		
THICKNESS OF CUTICLE PLUS OUTER PERICLINAL CELL WALL (µm.)	7-16	18-26.4
TOTAL HEIGHT OF CELL (µm.)	19.5-22	28.6-39.5
LOWER EPIDERMIS		
THICKNESS OF CUTICLE PLUS OUTER PERICLINAL CELL WALL (µm.)	10-11	16.5-22
TOTAL HEIGHT OF CELL (µm.)	18.5-23	22-33
INTERNODE LENGTH IN SEEDLING (cm.)‡	4-14	1-2.5
YOUNG PLANT		
GROWTH‡	Erect	Arching
INTERNODE LENGTH (cm.)‡	≥10	To 4
HABITAT‡	Swamp or riverside	Ridge forest or periodically inundated forest

\* Leaf anatomy of specimens cited in Stevens (1974a) has been examined.

† Leaf anatomy of specimens denoted by an asterisk in specimen citation has been examined.

‡ Based mainly on personal observations at Kiunga.

species with large, coriaceous leaves at Kiunga that differed most obviously in bark, seedling, and ecological preferences. Although it is not as easy to separate sterile material in the herbarium, this can be done using the characters listed in TABLE 18. *Calophyllum suberosum* and *C. persimile* have very similar hairs (FIGURE 39, o, p), twigs that dry yellowish, and large, coriaceous leaf blades with the midrib on the upper surface surrounded by raised blade. These characters alone distinguish the two species from all others in the genus. However, flowers of *C. suberosum*, ripe fruits of *C. persimile*, and observations on the ecology of both species from throughout their ranges are needed to clarify the relationship between them.

The differences in the seedling and young plant listed in TABLE 18 are independent of the environment. The first young plant of *Calophyllum persimile* that I saw was growing in a swamp with numerous seedlings and young plants of *C. suberosum*. The young plant of *C. persimile* had the characteristic arching and slow growth of the numerous young plants later seen in better-drained ridge forest.

There is some variation within *Calophyllum persimile*. The specimens cited from Japen Island (previously *Calophyllum* sp. C, aff. *C. savannarum*—see Stevens, *loc. cit.*) are similar in anatomy to the other specimens from Irian Jaya but are smaller in most of their parts (measurements in brackets in the description above); they are tentatively included in *C. persimile*. Leaves of *C. persimile* from the Western Province of Papua New Guinea lack a hypodermis, which is present in leaves of specimens from elsewhere in the range of the species (with the exception of LAE 53835). LAE 53835, from a sapling, has exceptionally long leaf blades (ca. 56 by 11 cm.) (Stevens, *loc. cit.*); it also has a rather thin cuticle plus outer periclinal epidermal wall complex on both the upper (ca. 15  $\mu$ m. thick) and the lower surface (ca. 10.5  $\mu$ m. thick) of the lamina. Van Royen & Sleumer 6561 has leaf blades that are bluntly pointed at the apex, and its bark is reported as being blackish brown, but it probably belongs to *C. persimile*.

150. *Calophyllum gracillimum* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 348. pl. 28. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 172. 1973; Corner, Gard. Bull. Singapore Suppl. 1: 104. 1978. TYPE: Malaya, Pahang, Bukit Balai, Rompin, 9 May 1919, KEP 2715 coll. Lambak (holotype, KEP; isotypes, K, SING).

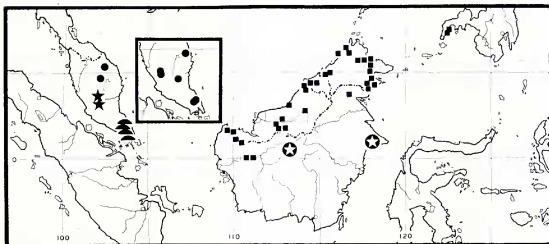
Tree to 15 meters tall, d.b.h. to 12 cm.; trunk without buttresses; outer bark pale greenish yellow-gray to biscuit colored, or pale brown and orange-brown mottled, with small lenticels in vertical rows, the inner surface dirty brown; under bark reddish; inner bark pale red; latex white or not apparent.

Twigs slightly flattened, 0.5–1 mm. across,  $\pm$  4-angled when young, soon becoming rounded, drying yellowish (rarely brown), transiently farinose to submentose; axillary innovations lacking basal scars; internodes 0.5–3.5 cm. long; uppermost pair of axillary buds pointed, to 1.5 mm. long, erect; terminal bud (narrowly) conical, 1.5–4 mm. long, with brown, submentose indumentum (hairs, FIGURE 43, k), underdeveloped internode absent. Petiole

2.5–4.5(–7) mm. long, deeply concave above, convex below, glabrescent, often drying blackish; lamina ovate to elliptic, (1.7–)3–7(–10.3) by (0.9–)1.4–3(–3.8) cm., bluntly acuminate to acute at apex, cuneate at base, slightly undulate but not recurved at margin, thinly coriaceous, drying umber to sepia above and fulvous to sabelline below, glabrescent except for few hairs on midrib below, the midrib above gradually narrowed from base, raised, or level except for raised basal 2 mm., ca. 0.15 mm. wide at midpoint, below raised, subangled to  $\pm$  flat, sometimes with at least margins impressed, the venation obscure on both surfaces, sometimes latex canals impressed above and especially below, 6 to 9 veins/5 mm., angle of divergence 60–70°. Inflorescences from foliate axils near ends of twigs, with 1 to 3 (to 5) flowers, unbranched, the axis to 2(–14) mm. long, short-tomentose, lowest internode to 2(–10) mm. long; bracts ovate, ca. 3.5 mm. long, soon deciduous (rarely foliaceous, ca. 1.4 cm. long); pedicels 3.5–5(–9) mm. long, short-tomentose. Flower (?)hermaphroditic; tepals 6 (rarely 7), the outer pair broadly ovate to suborbicular, 4–5.5 by 4–5 mm., puberulo-tomentose on back, the next pair elliptic, ca. 6 by 4.5 mm., with  $\pm$  broad strip of indumentum down back, the inner pair suboblong to elliptic, ca. 5. by (2–) ca. 3.5 mm.; stamens (?)numerous, the filaments to 3 mm. long, the anthers subelliptic to oblong, 0.4–0.7 mm. long, retuse at apex, with persistent hairs to 0.1 mm. long; ovary 1.3–2 mm. long, stigma and style unknown. Fruit spherical, ca. 1.1 by 1.1 cm., apiculate, drying vinaceous-brown, closely and sharply wrinkled; outer layer not detaching cleanly from stone, 0.5–0.9 mm. thick, compact; stone spherical, ca. 9 by 9 mm., rounded at apex, the walls ca. 0.2 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Malay Peninsula (MAP 46).

ADDITIONAL SPECIMENS SEEN. **Malaya.** SELANGOR: near the Gap, 800–900 m., *Ando et al.* 96 (probable) (KEP). TRENGGANU: Bukit Bauk F.R., *FRI* 2609 (?) (KEP, L, SING). PAHANG: Ulu Perah, *KEP* 11209 (KEP); Fraser's Hill, near



MAP 46. Distribution of *Calophyllum rotundifolium* (stars), *C. aureo-brunescens* (circles), *Calophyllum* sp. 151 (half-circles), *C. gracilipes* (squares), and *C. gracilipes* variant (stars in solid circles) in Malesia. Inset: *C. gracillimum*.

Jeriau waterfall, 975 m., *Stevens et al.* 20 (A). JOHORE: 13½ mile Mawai-Jemaluang road, *SFN* 28998 (A, BO, K, KEP, LAE, NY, P, SING).

**ECOLOGY.** Usually well-drained lowland or lower montane forest, also drier parts of swamp forest; to 975 m. alt. Flowering and fruiting February and May.

**YOUNG PLANT.** The plant is erect, and the terminal bud is functional.

*Calophyllum gracillimum* can be readily distinguished from other species of *Calophyllum* by its pale-drying twigs that often contrast with the blackish-drying petioles, and its small leaf blades that are bluntly acuminate at the apex, cuneate at the base, and with indistinct venation and often impressed latex canals. The inflorescences have one or a few flowers, and the anthers have hairs. The almost smooth, pale bark of the mature tree is also notable. The epithet *gracillimum* ("very slender") is appropriate for this species.

*Calophyllum gracillimum* is without obvious relatives. The small size of all its parts distinguishes it readily from the other taxa known to have hairs on their anthers (*C. canum* (sometimes); *C. molle*, and *C. rubiginosum*). It is superficially similar to the Fijian species *C. leucocarpum*, but the two can be easily separated as discussed under the latter species. *Calophyllum gracillimum* may be close to *Calophyllum* sp. 151, although the latter lacks hairs on its anthers and differs in a number of vegetative details (most obviously in its rounded twigs, longer petioles, midrib on the upper surface of the lamina surrounded by raised blade, and denser venation). More collections of both taxa are needed, especially from low altitudes in Johore where both occur; fruits of *Calophyllum* sp. 151 are not known.

Both *FRI* 2609 and *Ando et al.* 96 have twigs that dry dark brown, and although the latter specimen is probably *Calophyllum gracillimum*, the former may not be. It has rather prominent venation, an inflorescence with an axis to 1.4 cm. long bearing five flowers, and pedicels up to 9 mm. long. There is considerable variation in the development of the indumentum in *C. gracillimum*: specimens from Johore are short-tomentose on the twigs, while others are only farinose.

The uppermost measurements of the petiole and lamina in the description above are taken from sterile specimens, possibly saplings. The inflorescences are nearly always axillary (cf. Henderson & Wyatt-Smith, *loc. cit.*), although when borne in the uppermost leaf axils they may obscure the terminal bud, thus appearing to be terminal.

151. *Calophyllum* sp.

FIGURE 40, 1.

Tree 15–21 meters tall, d.b.h. to 25 cm.; trunk without spurs or buttresses; outer bark mottled brown-yellow, to pale brown, almost smooth (hoop marked), lenticels in vertical rows, the inner surface ± orange to pale brownish; under bark orange-reddish to orange-green; inner bark pale reddish; latex usually not obvious, slight moistening of cut surface, or colorless, not sticky (rarely opaque yellow, sticky).

Twigs somewhat flattened, (1.2–)1.6–2 mm. across, rounded, drying whitish



to grayish brown, sparsely puberulent when young; axillary innovations lacking basal scars; internodes 1.5–4 cm. long; uppermost pair of axillary buds rounded, 0.5–2 mm. long, erect; terminal bud plump to narrowly conical, 2.5–5 mm. long, with brown,  $\pm$  adpressed indumentum (hairs, FIGURE 43, i, j), underdeveloped internode absent. Petiole (0.4–)0.5–1.3 cm. long, broadly concave above, convex below, glabrescent; lamina ovate to subelliptic, (2.5–)4–6(–8.3) by (0.9–)1.7–3.2(–3.5) cm., rounded to subacute and  $\pm$  decurved at apex, acute to decurrent at base, slightly and distantly undulate but not recurved at margin, coriaceous, drying umber to near rosy buff above and sabelline to honey below, puberulent on midrib beneath when young, the midrib above narrowing gradually from base, initially strongly depressed, becoming raised, surrounding blade also raised, 0.2–0.3 mm. wide at midpoint, below raised,  $\pm$  angled, the venation above subobscure, apparent to subobscure below, flat or slightly raised, especially below, latex canals often impressed below, 8 to 13 veins/5 mm., angle of divergence 65–80°. Inflorescences from foliate axils near ends of twigs, with 5 (to 7) flowers, unbranched, the axis 0.6–1.4 cm. long, puberulent, lowest internode 3–7 mm. long; bracts elliptic-ovate, 1.8–2.8 mm. long, deciduous; pedicels 1–6.5 mm. long, puberulent. Flower (?) hermaphroditic; tepals 4, the outer pair suborbicular to elliptic, ca. 4.5 by 3.5–4 mm., puberulent on back, the inner pair elliptic-obovate, 5–6.5 by 4–5 mm., with puberulent strip down back; stamens 105 to 160, the filaments to 6.5 mm. long, perhaps with few minute hairs when young, the anthers elliptic, 0.35–0.6 mm. long, retuse at apex; ovary ca. 1.3 mm. long, the style unknown, the stigma peltate, 0.6–0.8 mm. across, 3-radiate. Fruit unknown.

DISTRIBUTION. Southern Malay Peninsula, Singapore (MAP 46).

ADDITIONAL SPECIMENS SEEN. **Malaya.** JOHORE: G. Pulai, 150 m., *Stevens et al.* 98 (A); Lenggong F.R., 30 m., *Stevens et al.* 60 (A); Renggam F.R., FRI 21635 (KEP), 240 m., *Stevens et al.* 46 (A), *Stevens et al.* 53 (= FRI 23440) (A), KEP 71267 (KEP); 42 miles, Mersing Road, Kluang, FRI 21621 (KEP); Panti F.R., KEP 70320 (?) (KEP), 5 m., *Stevens et al.* 112 (A). **Singapore:** Mandai forest (by zoo), 30 m., *Stevens et al.* 719 (A).

ECOLOGY. Well-drained lowland, mixed dipterocarp forest; sometimes in seasonally inundated forest; 5–240 m. alt. Flowering in November (all Malayan specimens); flower scented.

GERMINATION AND YOUNG PLANT. The seedling has one or two pairs of leaves separated by an internode 5–10 mm. long. Subsequently produced internodes are longer, the terminal bud is functional, and the plant is erect. The leaves of the seedling are 1.5–2.3 cm. wide; those produced in the first and immediately succeeding flushes are about half as wide. (*Stevens et al.* 46.)

*Calophyllum* sp. 151 can be characterized by its pale-drying, rounded twigs and its small leaves with relatively long petioles and blades that are rounded to subacute at the apices. The apex is rather strongly decurved, at least in the living leaf. The midrib on the upper surface of the lamina is initially depressed, but it soon becomes raised and is surrounded by raised blade. The inflorescence axis, pedicels, and backs of the outer and (partly) inner

tepals are all covered with indumentum; the flowers have four tepals and glabrous anthers.

*Calophyllum* sp. 151 may be related to *C. gracillimum*, but until both taxa are better known, it is premature to describe the former. The differences between the two are discussed under *C. gracillimum*.

152. *Calophyllum leptocladum* A. C. Smith & Darwin, Jour. Arnold Arb. 55: 221. figs. 4, 5. 1974, *pro majore parte*. TYPE: Fiji, Ngau, slopes of Mt. Ndelaita, on north spur, toward Navukailangi, 350–500 m., 22 June 1953, A. C. Smith 7874 (holotype, US; isotypes, A, K, NY).

Tree 9–22.5 meters tall; outer bark yellow, with narrow, longitudinal cracks.

Twigs flattened, 1.2–1.6 mm. across,  $\pm$  2-angled or rounded, drying brown to yellowish, brown-farinoso when young, or glabrous; axillary innovations lacking basal scars; internodes 0.5–2.5 cm. long; uppermost pair of axillary buds rounded (pointed), ca. 0.2(–0.5) mm. long, suberect to spreading; terminal bud narrowly conical, 2–3.7 mm. long, with brown to grayish, puberulent to subcrustose indumentum (hairs, FIGURE 43, e–h; cf. 37, o), underdeveloped internode absent (–1.5 mm. long). Petiole 4–10 mm. long, deeply concave above, convex below, glabrous when mature; lamina elliptic to suboblong, (2.8–)3.6–7(–8) by 1.4–2.4(–3.1) cm., acuminate at apex, acute to attenuate at base, slightly undulate or recurved at margin, thinly coriaceous, drying sepia to olivaceous above with midrib, margin, and venation often paler, umber to olivaceous below, glabrous or sparsely farinose on midrib below, the midrib above narrowed gradually from base,  $\pm$  raised, center strongly sulcate, surrounding lamina usually obscurely raised, 0.15–0.3 mm. wide at midpoint, below raised, subangled, the venation  $\pm$  apparent above and below, raised to subdepressed above, raised below, (10 to) 12 to 18 veins/5 mm., angle of divergence 60–75°. Inflorescences from foliate axils (very rarely terminal), with ca. 5 flowers, unbranched, the axis 0.6–1.5 cm. long, puberulent toward base, lowest internode 0.25–0.8(–1.2) cm. long; bracts narrowly ovate, to 2.5 mm. long, soon deciduous (rarely foliaceous, persistent); pedicels 0.2–1(–1.3) cm. long, glabrous. Flower (?)hermaphroditic; tepals 4, glabrous, the outer pair subelliptic, ca. 3 by 2.5 mm., the inner pair subobovate, to 4 mm. by 3 mm.; stamens ca. 60, the filaments to 2 mm. long, the anthers oblong, 0.6–1 mm. long, slightly retuse at apex; ovary ca. 1.3 mm. long, style ca. 1.5 mm. long, stigma peltate. Fruit ellipsoid, ca. 1.6 by 1.35 cm., rounded at apex, drying  $\pm$  vinaceous-tawny, irregularly wrinkled; outer layer detaching  $\pm$  cleanly from stone, 0.5–0.8 mm. thick, compact; stone ellipsoid, 1–1.35 by 0.85–1.15 cm., minutely apiculate, the walls 0.4–0.5(?)–0.8 mm. thick, smooth, unmarked; spongy layer (?)thin.

DISTRIBUTION. Fiji Islands, Viti Levu, rare on Vanua Levu.

SELECTED SPECIMENS SEEN. See Smith & Darwin, *loc. cit.*, excl. Howard 104 and FDA 15722. Also, Viti Levu. NAMOSI: Mt. Vakarogasiu, 671 m., FDA 16127 (CHR). TAILEVU: Colo-i-Suva, 210 m., Bola 11 (K). NAVUA: Kadawa, side of Kadawa Trig. Hill, 150 m., C.S.I.R.O. S 1404/7 (K); Sociri

Cr[EEK] (Kadava), Nabukelova distr., [FDA] H 419 (K). KANDAVU: Kandavu Is., 150 m., C.S.I.R.O. S 1404/3 (K).

ECOLOGY. Usually colline forest, (?18-)50-670 m. alt. Flowering December and March; fruiting in June (fruit nearly white).

Galls—small, narrow projections ca. 1.5 mm. high on the upper surface of the lamina—are common and occur on over half the collections.

LOCAL USE. The wood makes good timber (Smith & Darwin, *loc. cit.*).

*Calophyllum leptocladum* can be characterized by its small, narrow terminal bud and its rather small leaf blades with dense venation. It has small, four-tepaled flowers borne on few-flowered, axillary inflorescences. Its fruits are comparatively quite large (ca. 1.5 cm. long) and have a compact (0.5-0.8 mm.) outer layer that separates cleanly from the relatively thick (walls 0.4-0.5 mm. thick) stone. The epithet *leptocladum* means "slender (delicate) twigs."

*Calophyllum leptocladum* is at least superficially similar to *C. whitfordii* (from the Philippine Islands), and the two species have similar galls on the leaves. *Calophyllum whitfordii* can be most easily distinguished by its predominantly terminal inflorescences that nearly always have more than five flowers; the flowers have eight tepals. *Calophyllum whitfordii* also has leaves with less dense venation and a somewhat larger fruit with a thinner stone wall; the indumentum on the inflorescence axis extends to the pedicels and to at least the bases of the outer pair of tepals.

Smith and Darwin (*loc. cit.*) cited four specimens of *Calophyllum leptocladum* from Vanua Levu. Howard 104 is a specimen of *C. neo-ebudicum* and so, probably, is FDA 15722. Berry 4 and FDA 15733 seem to be *C. leptocladum*.

153. *Calophyllum whitfordii* Merr. Philip. Jour. Sci. 1 (Suppl.): 96. 1906, Enum. Philip. Fl. Pl. 3: 81. 1923, *pro majore parte*. TYPE: Philippine Islands, Luzon, Bataan Province, Lamao River, Mt. Mariveles, 2300 feet [701 m.], Feb. 1905, FB 2613 coll. Meyer (isotypes, K, NY, SING, US).

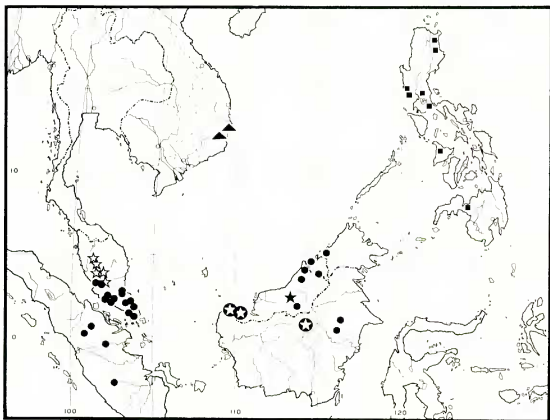
Tree to 28 meters tall, d.b.h. to 57 cm.; outer bark yellowish brown, fissured.

Twigs flattened, 1-2 mm. across, rather bluntly 4-angled, drying brown when young, later yellowish, at first farinose (puberulent); axillary innovations lacking basal scars; internodes 0.4-3.5 cm. long; uppermost pair of axillary buds pointed, to 1.5 mm. long, erect; terminal bud  $\pm$  conical to plump, 2.5-4.5(-6) mm. long, with grayish brown to brown, puberulo-tomentose indumentum (hairs, FIGURE 43, q-s, y), underdeveloped internode to 2 mm. long. Petiole (2.5-)5-11 mm. long, broadly concave above, convex below, subpersistently puberulent; lamina elliptic, 3.6-8.5 by 1.9-4.3 cm., bluntly acuminate to obtuse at apex, cuneate to acute at base (minutely rounded at very base), not recurved but slightly undulate at margin, coriaceous, drying umber to sepia above and cinnamon-sepia to sabelline-olivaceous below, subpersistently puberulent on midrib above and especially below, the midrib above narrowing gradually from base, slightly to strongly raised, sulcate or not, 0.07-0.25 mm. wide at midpoint, below raised,  $\pm$  angled, the venation above and below  $\pm$  apparent, raised, (6 to) 9 to 13 (to 15) veins/5 mm.,

angle of divergence 60–70(–75)°. Inflorescences terminal and/or axillary, with 7 to 15 flowers, often flabellate, usually with branches up to 2 cm. long and with 5 flowers, the axis 2–6 cm. long, puberulent, lowest internode at least 1.2 cm. long; bracts unknown; pedicels 5–11 mm. long, puberulent. Flower (?)hermaphroditic; tepals 8, the outer pair broadly ovate, 4.5–5 by ca. 4 mm., puberulent on back, the inner ones oblong to obovate or elliptic, 8–9 by 2.5–5 mm., outer two sometimes puberulent in strip down back; stamens 125 to 230, the filaments to 4.5 mm. long, the anthers oblong, 0.7–1.5 mm. long, retuse at apex; ovary 1.7–2 mm. long, the style to 3 mm. long, the stigma peltate, ca. 0.8 mm. across, 3- or 4-radiate. Submature fruit spherical to ellipsoid, 1–1.5 by 0.8–1.4 cm., apiculate, drying fuscous-black, finely striate to wrinkled; outer layer not detaching cleanly from stone, 0.5–0.8 mm. thick, compact; stone subspherical, 0.9–1.4 by 0.7–1.3 cm., rounded at apex, the walls 0.15–0.3 mm. thick, at base 0.5–1 mm. thick, smooth, (?)unmarked; spongy layer initially well developed.

DISTRIBUTION. The Philippine Islands (MAP 47).

SELECTED SPECIMENS SEEN. **Philippine Islands.** LUZON. Cagayan: sine loco, *FB* 6667 (US). Isabela: Mt. Moises, *Clemens* 16766 (?) (UC). Zambales: Subig, *Merrill* 1759 (K, NSW, NY, US). Bataan: Mt. Mariveles, Lamao R., *FB* 785



MAP 47. Distribution of *Calophyllum rugosum* (triangles), *C. aureum* (open stars), *C. rubiginosum* (circles), *C. recurvatum* (stars in solid circles), *Calophyllum* sp. 164 (solid star), and *C. whitfordii* (squares) in Southeast Asia-Malesia.

(BM, BO, F, K, LY, NSW, NY, P, SING, US). Laguna: Famy, Minayotan, 442 m., *PNH 39394* (A, PNH, SING). Quezon: Malikboy, *FB 31478* (NY). MINDORO: sine loco, *FB 6855* (BO, LY, NY, US). MINDANAO. Davao: Mt. Galintan, 150 m., *BS 48913* (NY, UC).

ECOLOGY. Colline forest, 150–700 m. alt. Flowering January to March; submature fruit May to July.

Conoid galls 1–1.5 mm. tall are frequent on the lower and sometimes on the upper surface of the lamina.

*Calophyllum whitfordii* can be recognized by its small, conical, terminal buds usually less than 4.5 mm. long; its elliptic, rather small lamina that dries umber to sepia and often more or less nitid on the upper surface; its puberulent, terminal inflorescences; and its spherical, shallowly wrinkled fruit with a compact outer layer. Small, conoidal galls on the lamina are common. The epithet commemorates H. N. Whitford.

Although there is considerable variation in the prominence of the midrib on the upper surface of the lamina (in specimens such as *BS 48913* it is almost flat), this variation is not correlated with that of other characters. *Clemens 16766* has very short petioles (figures in parentheses in the description above).

The circumscription of *Calophyllum whitfordii* has given me much trouble. I originally thought that it was part of the variable *C. blancoi* complex, and it may be related to that species. However, its leaves do not dry grayish or so strongly bicolored as in *C. blancoi*; they are often more or less nitid on the upper surface and are smaller than is usual for *C. blancoi*. The conoidal galls so common in *C. whitfordii* are uncommon in *C. blancoi*, and the hairs of *C. whitfordii* are less branched than is usual in *C. blancoi*. The terminal bud of *C. blancoi* is plump and nearly always considerably larger than that of *C. whitfordii*, and there are minor differences in the fruit. *Calophyllum whitfordii* is also superficially similar to *C. leptocladum*, from the Fiji Islands, but these two species can be more easily separated (see *C. leptocladum*).

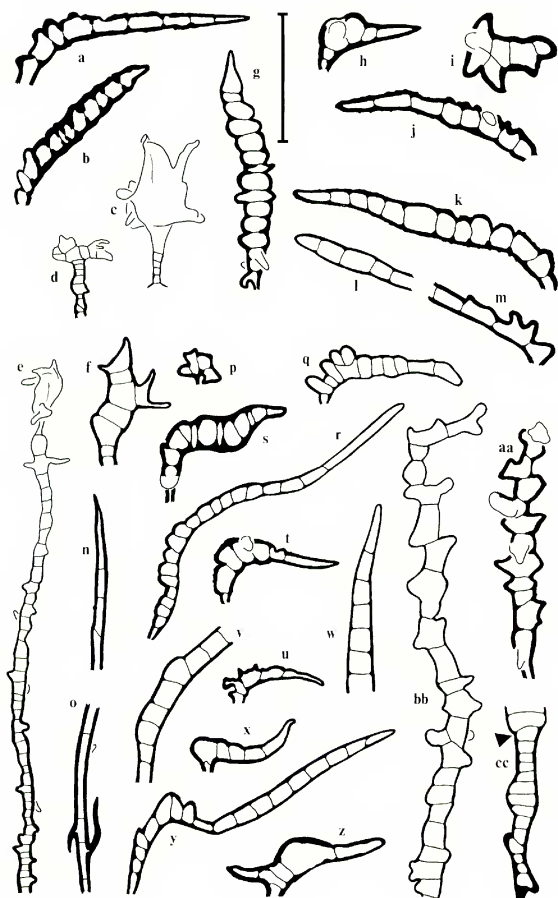
154. *Calophyllum rugosum* P. F. Stevens, sp. nov.

FIGURE 40, a–c.

A speciebus aliis Calophylli in gemma terminali 2.5–4.5 mm. longa, lamina mediocri venulis lateralibus 3 usque ad 7 per 5 mm. saepe prominentioribus in pagina supra quam in pagina infra, inflorescentia terminali, et fructu in siccitate valde rugoso parietibus putaminis tenuis, differt.

Tree 5–12 meters tall, d.b.h. ca. 20 cm.; bark unknown.

Twigs flattened, 1.2–2 mm. across, 2- or  $\pm$  [strongly] 4-angled, drying dark brown to blackish, puberulent when young; axillary innovations lacking basal scars; internodes 0.6–6 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, erect; terminal bud conical to plump, 2.5–4.5 mm. long, with subadpressed, brown indumentum (hairs, FIGURE 41, a, b), underdeveloped internode absent (to 1 mm. long). Petiole [1.5–] 4–10 mm. long, strongly concave above, convex below, glabrous at maturity; lamina elliptic to obovate (rarely suborbicular) [lingulate], 1.6–10.5 by 1.4–5.4 cm., rounded to shallowly retuse



at apex, cuneate to broadly rounded [cordate] at base, not undulate to distantly so and slightly recurved at margin, coriaceous to very coriaceous, drying cinnamon-sepia above and sabelline to cinnamon below, puberulent on midrib below when young, the midrib above abruptly narrowed at base, at first slightly depressed, becoming flat or slightly raised, 0.15–0.25 mm. wide at midpoint, below slightly raised, margins depressed, becoming subdepressed toward apex, the venation apparent (obscure) above, often obscure below, raised (subdepressed), 2 to 7 veins/5 mm., angle of divergence 50–75°. Infructescences terminal and from adjacent axils, with scars of up to 19 flowers (with 5-flowered branches up to 5 mm. long), the axis up to 5 cm. long, subtomentose to puberulent especially near base, lowest internode 1–2 cm. long; bracts unknown; pedicels 1.3–2.1 cm. long, glabrous. Damaged flower only known; tepals 6, the outer pair ovate-elliptic, ca. 6 by 5 mm. Fruit spherical to ellipsoid, 2–2.2 by 1.7–2 cm. (but see discussion), rounded to apiculate, drying brown-vinaceous, deeply wrinkled; outer layer detaching more or less cleanly from stone, 0.5–1.5 mm. thick, compact; stone ellipsoid to spherical, ca. 1.9 by 1.6–1.75 cm., rounded at apex, the walls ca. 0.25 mm. thick, smooth, not marked; spongy layer at first well developed.

TYPE: Indochine [Vietnam], Annam, Massif du Bi-Doupprès du Haut Donai, 2000 m., 14 Oct. 1940, *Poilane* 30918 (holotype, A; isotypes, P (several)).

DISTRIBUTION. Vietnam (MAP 47).

ADDITIONAL SPECIMENS SEEN. **Vietnam:** Nhatrang, 1800 m., *Poilane* 3494 (A, P), massif du Hòn Bà, 1000–1500 m., *Chevalier* 38865 (P).

ECOLOGY. Open, shrubby montane vegetation, rocky soil or “bordure grande forêt et celle de pin”; 1000–2000 m. alt. Submature fruit in October; fruit and peduncle pale, watery green.

*Calophyllum rugosum* can be recognized by its rather small terminal bud, its medium-sized lamina that is variously shaped at the base but always more or less rounded at the apex, its terminal inflorescence, and its deeply wrinkled fruits. The venation is often more prominent on the upper side

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FIGURE 41. Hairs (from terminal bud, unless otherwise noted). a, b, *Calophyllum rugosum*: a, *Poilane* 3494; b, *Poilane* 30918. c–f, *C. rubiginosum*: c, f, *Soepadmo* 86, from stem; d, *Maingay*, *Kew dist.* 168; e, *Samat bin Abdullah* 2174. g, *C. rotundifolium* (Robinson s.n.). h–j, *C. sakarium* (SAN 21612), axillary bud; i, from above. k–m, *C. obliquinervium*: k, SAN 33609; l, m, *PNH* 14132, apex and base of hair ca. 330  $\mu$ m. long. n, o, *C. molle* (FRI 8285), apex and base of hair ca. 510  $\mu$ m. long. p–r, bb, cc, *C. gracilipes*. p, *S* 22401. q, *Hallier* 2992. r, *Williams* 2193. bb, cc, *Kostermans* 6013: bb, apex of hair (base similar to portion below arrow in cc); cc, basal part of hair ca. 1230  $\mu$ m. long (apex similar to w). s, y, *C. aurantiacum* (Stevens et al. 195). t, u, *C. echinatum*: t, *Cel.*/II-407; u, *Cel.*/II-215. v, w, *C. recurvatum* (S 7737), hairs to 720  $\mu$ m. long, base and apex of hair ca. 500  $\mu$ m. long. x, z, *C. brachyphyllum* (BS 34482). aa, *C. ardens* (BRUN 297), axillary bud. Scale = 120  $\mu$ m. (in c–e, scale = 240  $\mu$ m.).

of the lamina than on the lower, and the veins are relatively distant (3 to 7/5 mm.). The epithet *rugosum* ("wrinkled") was considered appropriate because the dried fruits are so strongly wrinkled.

The closest relative of *Calophyllum rugosum* is probably *C. rotundifolium*. The leaves of *Chevalier 38865* are almost identical to those of *Stone 7174* (*C. rotundifolium*), and the general color on drying and venation prominence of the leaves of *Poilane 3494* are also similar. The two species have similar hairs, with rather thick-walled cells about as broad as long. Lamina anatomy is also similar, although the anticlinal walls of the upper epidermis of *C. rotundifolium* (*Stone 7174*) are at most inconspicuously sinuous near the top, while those of all collections of *C. rugosum* are characteristically sinuous for much of the height of the cell (this may be only a trivial difference). Both species have a short palisade mesophyll, lignified spongy mesophyll, and vascular bundles that are not transcurrent abaxially (although they are transcurrent in *Poilane 30918*). The inflorescences of the two are quite different: in *C. rotundifolium* the axis is absent, while in *C. rugosum* it is well developed; the characteristic thick outer tepals of the flowers of *C. rotundifolium* do not occur in *C. rugosum*. The fruits of *C. rotundifolium* are unknown.

The three specimens assigned to *Calophyllum rugosum* are at first sight very different. *Poilane 30918* has long internodes and relatively large leaf blades that are cuneate or rounded at the base. *Poilane 3494* has short internodes and smaller leaf blades that are broadly rounded at the base. *Chevalier 38865* has long internodes and rather large, subsessile leaf blades that are cordate at the base; it is superficially very different from the other specimens (the characters in which it differs are enclosed in brackets in the description above). However, in anatomy, terminal bud, indumentum, general leaf type, and inflorescence position, all three are similar (although *Poilane 30918* has veins more or less prominent on the lower surface of the lamina, and—as might be expected—vascular bundles transcurrent abaxially in transverse section). The description of the flower is taken from a very damaged bud found between the leaves (not attached to the shoot) of *Poilane 3494*. *Chevalier 38865* has immature fruits that would possibly be about 1.5 cm. long when mature; in drying characteristics and general type they are similar to those of the type specimen.

*Poilane 5083* (Nhatrang, Mère et l'Enfant, 2000 m. (p)) has a facies similar to that of *Calophyllum rugosum*, but it has a terminal bud ca. 6 mm. long, axillary inflorescences, flowers with eight tepals, a better-developed palisade mesophyll, and a thinner-walled upper epidermis with the anticlinal walls only very slightly sinuous near the top.

155. *Calophyllum rotundifolium* Ridley, Jour. Fed. Malay States Mus. 5: 29. 1915, Fl. Malay Penin. 1: 188. 1922; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 337. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 168. 1973. TYPE: Malaya, Selangor, Gunong Mengkuang [Lebah], 5000 feet [1524 m.], 17 Jan. 1913, *Robinson s.n.* (holotype, SING; isotypes, BM, K).



Tree ca. 9 meters tall, d.b.h. ca. 23 cm.; outer bark ochre, smooth, or surface cracked, with large lenticels; latex translucent.

Twigs flattened, 1.5–2 mm. across, slightly angled, drying dark brown, puberulent when young; axillary innovations lacking basal scars; internodes 1–4 cm. long; uppermost pair of axillary buds  $\pm$  rounded, 1–2 mm. long, erect, conspicuous; terminal bud plump, 2–3 mm. long, with short, brown, tomentose indumentum (hairs, FIGURE 41, g), underdeveloped internode not apparent. Petiole ca. 0.5 mm. long, concave above, convex below,  $\pm$  glabrous; lamina  $\pm$  orbicular, (1–)2.5–6.5 by (0.7–)2.4–5.5 cm.,  $\pm$  retuse at apex, cordate at base, neither undulate nor recurved at margin, coriaceous, drying umber above and cinnamon-sabelline to umber below, subsersistently puberulent on midrib below, the midrib above narrowing quickly at base,  $\pm$  depressed at first, becoming raised, 0.1–0.3 mm. wide at midpoint, below impressed or slightly raised,  $\pm$  angled, the venation above subapparent, raised, below obscure to invisible, 7 to 10 veins/5 mm., angle of divergence (50–)60–70°. Inflorescences terminal, with 1 (rarely 2) flower(s), axis absent; bracts unknown; pedicels 1.1–1.6 cm. long,  $\pm$  glabrous. Flower (?)hermaphroditic; tepals 8, the outer pair elliptic to ovate, 0.6–1.2 by 0.4–0.9 cm., flat to subconcave, coriaceous, glabrous, the next pair  $\pm$  orbicular, 1.3–1.4 by ca. 1 cm., concave, the inner ones obovate, 1.2–1.4 by 0.8–1 cm.; stamens ca. 200, the filaments 4–8 mm. long, at base connate for 1.5–2 mm., the anthers oblong, 1–1.8 mm. long, rounded to retuse at apex; ovary ca. 3 mm. long, the style ca. 3 mm. long, the stigma peltate, ca. 1.5 mm. across,  $\pm$  3-radiate. Fruit unknown.

DISTRIBUTION. Malaya, the southern part of the Main Range (MAP 46).

SELECTED SPECIMENS SEEN. **Malaya.** PAHANG/SELANGOR: G. Ulu Kali, 1738 m., *FRI 12585* (KEP), 1800 m., *Stone 8416* (KLU). SELANGOR: G. Mengkuang Lebah, 1646 m., *Derry s.n.*, 4 Mar. 1907 (SING).

ECOLOGY. Stunted montane forest, 1525–1800 m. alt. Flowering in January.

*Calophyllum rotundifolium* is a distinctive species characterized by its suborbicular leaf blades with the venation less prominent on the lower surface than on the upper, and by its usually single, terminal flowers with eight tepals, the outer pair of which are coriaceous and almost leaflike. The epithet *rotundifolium* ("round leaves") is very appropriate for this species.

*Calophyllum clemensorum*, from Borneo, has been confused with *C. rotundifolium*, but the two are probably not close since the former has leaf blades with clearer venation about equally prominent on both surfaces and a terminal inflorescence with an axis 2–4 cm. long. The closest relative of *C. rotundifolium* is probably *C. rugosum*, from Vietnam (for the differences separating them, see *C. rugosum*).

The thick, rather leaflike outer tepals of *Calophyllum rotundifolium* are distinctive. Although exceeding some of the leaves in size, they have steeply ascending (rather than widely divergent) venation and lack a midrib. It is possible that these outer tepals are bracts, but no buds were seen in their axils. Ridley (1915, *loc. cit.*) described the "inner sepals" as being only

2 mm. long, and although later authors have followed him in this, they appear to have been mistaken. Henderson and Wyatt-Smith (*loc. cit.*) described the venation on the upper side of the leaf as less prominent than that on the lower. This is normally the case in *Calophyllum*, but it is clearly otherwise in this species.

Leaf blades of saplings are suboblong and are up to 13 by 6.6 cm. (Derry *s.n.*, Stone 8416). In such specimens the terminal bud is up to 7 mm. long.

156. *Calophyllum aureo-brunnescens* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 341. pl. 21. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 172. 1973. TYPE: Malaya, Pahang, Gunong Tahan, 5000 feet [1524 m.], 11 June 1922, SFN 7855 coll. Haniff & Nur (holotype, SING; isotypes, K, KEP).

*C. venustum* auct., non Ridley; Ridley, Jour. Fed. Malay States Mus. 2: 110. 1909.

Tree 3–4.5 meters tall; trunk and bark unknown.

Twigs flattened, 1.5–3 mm. across, rounded, drying dark brown, sparsely puberulent when young; axillary innovations lacking basal scars; internodes (2–)3–5.5 cm. long; uppermost pair of axillary buds subacute, to 2.5 mm. long, suberect to spreading; terminal bud narrowly conical, 3.5–8 mm. long, with pale brown, crustaceous indumentum (hairs, FIGURE 43, l; also moruloid), underdeveloped internode 1–6(–10) mm. long. Petiole 0.8–1.3 cm. long, broadly and rather shallowly concave above, convex below, glabrous when mature; lamina elliptic (rarely subovate or subobovate), (2.7–)3.5–6.7 by (1.1–)1.8–3.3 cm., acute to obtuse (retuse) at apex, acute at base, neither undulate nor recurved at margin, coriaceous, drying mid to dark brown above, paler and ± pruinose below, sparsely puberulent on midrib below when young, the midrib above narrowing gradually from base, margins not clear, ± depressed at first, becoming level, 0.2–0.35 mm. wide at midpoint, below raised, ± striate (angled toward apex), the venation subapparent to obscure above, subapparent below, raised, (9 to) 11 to 16 veins/5 mm., angle of divergence (45–)50–70°. Inflorescences terminal and from adjacent foliate axils, with 7 to 11 flowers, branched or not, often flabellate, the axis 2.5–5 cm. long, inconspicuously farinose, lowest internode 1.3–3.5 cm. long; bracts ± obovate, ca. 4 mm. long, soon deciduous; pedicels 0.7–1.1 cm. long, puberulent. Flower (?)hermaphroditic; tepals 8 (rarely 9), the outer pair broadly ovate, 6.5–7 by ca. 5 mm., the inner ones elliptic to obovate, 7–9 by 2.2–4 mm.; stamens ca. 200, the filaments to 3.5 mm. long, the anthers elliptic-oblong, 0.6–1.1 mm. long, retuse to apiculate; ovary 1.8–2 mm. long, style and stigma unknown. Fruit unknown.

DISTRIBUTION. Northeastern Malaya (MAP 46).

SELECTED SPECIMENS SEEN. **Malaya.** PAHANG: G. Tahan, Ridley 16015 (BM, K, SING); Padang Luas, 1676 m., F.M.S. Museum 12240 (SING); G. Ulu Kechau, 1829 m., KEP 42911 (K, KEP).

ECOLOGY. Montane forest, 1525–1830 m. alt. Flowering May to July.

*Calophyllum aureo-brunnescens* is an imperfectly known species that can be characterized by its rounded twigs, its narrowly conical terminal buds, its suberect to spreading uppermost pair of axillary buds, its rather small, basically elliptic lamina that is usually other than retuse at the apex, and its terminal inflorescence with eight-tepaled flowers. The epithet *aureo-brunnescens* means "gold-brownish"; I am not sure why it was coined.

It has been suggested that *Calophyllum aureo-brunnescens* may be close to *C. aureum*; for discussion see *C. aureum*.

157. *Calophyllum aureum* Symington ex M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 340. pl. 20. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 171. 1973. TYPE: Malaya, Pahang, Cameron Highlands, Gunong Beramban, 5 June 1933, KEP 31007 coll. Symington (holotype, SING; isotypes, K, KEP).

Shrub or tree 2.5–15 meters tall, d.b.h. to 38 cm.; trunk (?)unbuttressed; outer bark yellowish to ochre, smooth at first, becoming fissured; inner bark red-brown; latex clear golden or opaque cream.

Twigs strongly flattened, 1.2–2.5 mm. across, 4-angled, drying dark brown, yellowish brown when much older, transiently subglabrous or farinose-puberulent; axillary innovations lacking basal scars; internodes 2–6.5 cm. long; uppermost pair of axillary buds pointed, 1.5–3.5 mm. long, erect; terminal bud narrowly conical to somewhat plump, (3.5–)4.5–6 mm. long, with subfur-furaceous grayish brown to submentose rufous indumentum (hairs, FIGURE 43, p), underdeveloped internode absent. Petiole 4.5–9.5 mm. long, concave above, convex below, glabrescent; lamina obovate (rarely subelliptic), 2–5 by 1.3–3.6 cm., retuse (very rarely rounded) at apex, cuneate to acute at base, broadly undulate or not and not recurved to slightly so at margin, entire lamina drying  $\pm$  concave, coriaceous, sabelline-olivaceous above and sepia below, when young farinose on midrib below, the midrib above abruptly narrowed at base, raised to subdepressed, with raised margins, 0.15–0.25 mm. wide at midpoint, disappearing just short of apex or not, below raised, striate (subdepressed toward apex), the venation above apparent, below subobscure to apparent, raised to level, 12 to 19 veins/5 mm., angle of divergence (55–)65–75°. Inflorescences terminal (also from uppermost pair of foliate axils), with 7 to 13 flowers, often with 3-flowered branches to 1.5 cm. long, frequently flabellate, the axis to 4 cm. long, farinose to puberulent at least near base, lowest internode 1.5–3.2 cm. long; bracts foliaceous, to 2 cm. long, subpersistent; pedicels 0.6–1.1 cm. long, glabrous (sparsely farinose toward base). Flower (?)hermaphroditic; tepals 8, the outer pair broadly ovate, 5.5–6.5 by 4.5–5.5 mm., the inner ones elliptic to obovate, 9–10 by 4–6 mm.; stamens ca. 150, the filaments to 4.5 mm. long, the anthers oblong, 1.2–1.5 mm. long, subacute to retuse at apex; ovary ca. 2 mm. long, the style ca. 3 mm. long, the stigma peltate, ca. 0.8 mm. across, 3- or 4-radiate. Immature fruit ovoid, ca. 1.8 by 1.4 cm., apiculate, drying brown, smooth; outer layer ca. 1.2 mm. thick; stone walls probably very thin.

DISTRIBUTION. Malaya, the Main Range (MAP 47).

SELECTED SPECIMENS SEEN. **Malaya.** PERAK: G. Korbu, 1524–2134 m., *KEP* 32118 (K, *KEP*). PAHANG: Cameron Highlands, Bukit Mentigi, 1524 m., *Chew* 860 (A, AAU, G, K, *KEP*, SING, UC), path to G. Beramban, 1494 m., *FRI* 15675 (*KEP*, L); G. Benom, 1829 m., *FRI* 3305 (*KEP*), Kluang Terbang, *Barnes s.n.* (SING). SELANGOR: Fraser's Hill, *KEP* 11468 (*KEP*, SING); G. Bunga Bua, *FRI* 307 (*KEP*, SING).

**ECOLOGY.** Lower montane forest (trees on ridges very stunted), 1490–2135 m. alt. Flowering June and October; flower cream, fragrant.

*Barnes s.n.* and *Chew* 860 have leaves modified as bilabiate galls, perhaps caused by coccids.

*Calophyllum aureum* can be characterized by its uppermost pair of axillary buds, which are long and erect; its long internodes; its small, usually obovate and retuse lamina that dries grayish green above with the midrib brownish, and brown to golden brown below; and its relatively few-flowered, farinose-puberulent terminal inflorescences with widely spreading branches and persistent bracts. The epithet *aureum* ("gold") alludes to the yellowish bark.

*Barnes s.n.* was cited under *Calophyllum aureo-brunnescens* by Henderson and Wyatt-Smith (*op. cit.*); they thought that it was intermediate between that species and *C. aureum*. However, *Barnes s.n.* is merely a poor, galled specimen of *C. aureum*; *FRI* 3305, also from G. Benom, is more obviously this species. The fruits of both *C. aureum* and *C. aureo-brunnescens* are still unknown; the two species may not be closely related.

158. *Calophyllum rubiginosum* M. R. Henderson & Wyatt-Smith, *Gard. Bull. Singapore* 15: 308. *pl.* 5. 1956; Smythies, *Common Sarawak Trees*, 61. 1965; Kochummen, *Malayan Forest Rec. ed. 2.* 17: 215. 1965; T. C. Whitmore, *Tree Fl. Malaya* 2: 189. 1973; H. Keng, *Gard. Bull. Singapore* 28: 245. 1976; Corner, *Gard. Bull. Singapore Suppl. 1*: 104. 1978. **TYPE:** Malaya, Negri Sembilan, Berembun-Angsi Reserve, Bukit Tangga, 25 Feb. 1918, *KEP* 1953 coll. *Kinsey* (lectotype, *KEP*; isolectotype, K, SING). FIGURE 40, i.

*C. wallichianum* auct., non Planchon & Triana; King, *Jour. Asiatic Soc. Bengal*, II. 59: 179. 1890, *quoad descr.*; Ridley, *Jour. Straits Branch Roy. Asiatic Soc.* 33: 48. 1900, *Fl. Malay Penin.* 1: 187. 1922, *pro parte*; M. R. Henderson, *Gard. Bull. Straits Settl.* 4: 224. 1938; Foxworthy, *Malayan Forest Rec.* 3: *fig.* 1927.

*C. muscigerum* Boerl. & Koord. ex Heyne, *Nutt. Pl. Nederl.-Indië*. ed. 2. 2: 1085. 1927, *ibid.* ed. 3. 1: 1085. 1950; Pukol & Ashton, *Checklist Brunei Trees*, 93. 1964. *Nomen.*

*Calophyllum* sp. *Koord.-Schum. Syst. Verzeich.* 2: 40. 1910.

Tree 7.5–39 meters tall, d.b.h. to 77 cm.; trunk without buttresses (with small spurs); outer bark brownish at first, becoming grayish to yellowish or ochre, with long, shallow fissures, or rugulose with minute cracks, flaking or scaling, hoop marked, the inner surface yellow to orange; under bark orange-straw to deep red; inner bark red; latex white, sticky or not.

Twigs flattened, 2–3.5 mm. across, strongly 2- or 4-angled, drying whitish

or yellowish, subpersistently brown-tomentose (rarely puberulent); axillary innovations lacking basal scars; internodes (1-)2-7 cm. long; uppermost pair of axillary buds pointed, 1-2 mm. long, erect; terminal bud plump, 4-8 mm. long, with brown, short-tomentose to puberulent indumentum (hairs, FIGURE 41, c-f), underdeveloped internode absent (-2 mm. long). Petiole 0.5-3 cm. long, slender, narrowly to broadly concave above, convex and  $\pm$  persistently short-tomentose below; lamina elliptic to suboblong or ovate, (4.5-)7-16 by (1.6-)2-5.7 cm., acute to acuminate at apex, acute to subdecurent (rarely rounded) at base, distantly and  $\pm$  deeply undulate and plane to slightly recurved at margin, coriaceous, drying olivaceous to umber above and clay or cinnamon-sabelline to sienna-umber below, color often obscured by ferrugineous indumentum, usually tomentose (rarely puberulent) on both surfaces initially, becoming glabrescent above, the midrib above narrowing gradually from base, sharply raised, 0.2-0.5 mm. wide at midpoint, below strongly raised,  $\pm$  striate, the venation subobscure on both surfaces, raised to depressed, latex canals as clear as veins, 8 to 14 veins/5 mm., angle of divergence 70-80°. Inflorescences terminal and from adjacent foliate axils, with 7 to 15 flowers (very rarely single, terminal flower), unbranched, often flabellate, the axis 2.5-7 cm. long, short-tomentose, lowest internode 0.5-1.7 cm. long; bracts  $\pm$  linear, to 3.2 cm. by 2 mm., soon deciduous; pedicels 3.5-16 mm. long, short-tomentose. Flower (?) hermaphroditic; tepals (4 or) 8, the outer pair ovate, 5.5-6.5 by 3.5-5.5 cm., tomentose on outer and inner surfaces, especially near apex, the next pair (broadly) elliptic, 7.5-9 by 4-5.5 mm., tomentose in band down back, the inner ones obovate to subelliptic, to 8 by 4 mm.; stamens 130 to 235, the filaments to 5.5 mm. long, the anthers suboblong, 0.6-1 mm. long, rounded to slightly retuse at apex, with subpersistent hairs to 0.2 mm. long; ovary 1.5-1.7 mm. long, the style to 2.5 mm. long, the stigma subpeltate, to 0.9 mm. across, 3-radiate. Fruit ovoid-ellipsoid, 2-2.2 by 1.4-1.8 cm.,  $\pm$  acute at apex, drying brown, sharply and prominently wrinkled, furfuraceous; outer layer detaching cleanly from stone or not, ca. 1.5 mm. thick, compact; stone ellipsoid, ca. 1.7 by 1.4 cm., rounded at apex, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southern Malay Peninsula to Sumatra and Borneo (MAP 47).

SELECTED SPECIMENS SEEN. **Malaya.** SELANGOR: Bukit Lagong F.R., 502 m., *KEP 83675* (KEP); Bangi F.R., *KEP 10974* (KEP, P); Rantau Panjang, *KEP 14772* (KEP, P); Kuala Lumpur, Jalan Rajah, *KEP 10470* (E, K, KEP, NY, SING); Kepong, F.R.I. plantation, *KEP 38507* (K, KEP, SING, US); Sungei Buloh F.R., 240 m., *KEP 99637* (A, KEP, SAR); Kuang F.R., *KEP 21962* (KEP, NY, P); Ayer Hitam F.R., *KEP 10903* (KEP); Kanching, *KEP 14782* (KEP); Weld Hills F.R., *KEP 2615* (KEP); Ulu Gombak F.R., *KEP 11645* (KEP, NY, SING); Bukit Cheraka F.R., *KEP 65567* (KEP); Bukit Tunggal F.R., *KEP 23644* (KEP); Ulu Langat F.R., *KEP 53604* (KEP); Ampang F.R., *FRI 16054* (KEP, SING); Kajang, *KEP 2649* (KEP); 12th mile Bentong road, *Samat bin Abdullah 174* (A, G, KLU). MALACCA: 15th mile Sungei Udang F.R., *Sinclair 8937* (B, E, K, SING); Ayer Panas F.R., *KEP 25253* (K, KEP); Batang Malaka F.R., *KEP 2063* (K, SING); Ramuan China F.R., *KEP 25257* (BO, KEP). NEGRİ SEMBILAN: Sungei Menyala F.R., *KEP 64654* (KEP, SING); Senawang F.R., *KEP 18505* (A, K, KEP, SING);

Gunong Angsi F.R., 457 m., *FRI 17332* (K, KEP, SAR, SING). PAHANG: ca. 10 km. S. of Kampong Aur, *FRI 15895* (KEP); Lesong F.R., 150 m., *FRI 19843* (KEP, SAR). JOHORE: Kluang Forest, *FRI 8709* (A, K, KEP, SAR, SING); Jemaluang F.R., *KEP 69995* (KEP); Sungei Kayu, *Kiah s.n.*, 28 Oct. 1936 (SING). SINGAPORE: Bukit Timah, *Ridley 6196* (A, E, K, NSW, P, SING); NE. end MacRitchie Reservoir, *SFN 39634* (BO, E, K, P, SING); Chua Chu Kang, *Ridley s.n.*, anno 1894 (SING); Botanic Gardens, *SGN 1668* (SING). SUMATRA. RIAU: Indragirische Bovenlanden, Danau Mengkoeang, 60 m., *bb 27550* (BO, L); Upper Riau, Pakanbaru, Tenajan R., *Soepadmo 86* (A, B, BO, C, E, LAE, NY, SING). SELATAN: Rawas, 100 m., *Grashoff 970* (BO, L). "Central, Nogul Droog," *Koorders 15779* (BO). BORNEO. SARAWAK. 3rd Division: Melinau, Ulu Selada, path to Bukit Mabong, 305 m., *S 24266* (L, SAN, SAR, SING). 4th Division: Baram, Sungei Beling, *FA 636* coll. *Egon*, 24 May 1948 (SAR); Poak, *Hose s.n.*, 8 Nov. 1911 (BM). BRUNEI: Kuala Beblong, 60 m., *Ashton s.n.*, Oct. 1959 (SAR). SABAH. Beaufort: Beaufort Hill, *SAN 36900* (SAN). KALIMANTAN. TIMUR: C. Kutei, Belajan R., G. Kelepok near Tabang, 250 m., *Kostermans 10584* (BO, CANB, K, KEP, L, NY, P, SING); W. Koetei, Long Bleh, 30 m., *bb 16059* (A, BO).

ECOLOGY. Lowland or colline forest, 30–500 m. alt. Flowering January to May, and July and August (flower scented); fruiting April to July, and October to December (fruit brownish green).

YOUNG PLANT. The young plant is erect, and the terminal bud is functional.

LOCAL USES. The wood, although susceptible to termite attack, is used in construction. The latex is very poisonous and, mixed with rice, is used to exterminate rats (Heyne, *loc. cit.*). It is also reportedly used as a poison to stun fish (*Kostermans 10584*, Kalimantan); in the 3rd Division of Sarawak the latex of *C. rubiginosum*, or another species with white latex, is placed in small dams and left overnight for this purpose (Banyeng ak Nudong, pers. comm.).

*Calophyllum rubiginosum* is a distinctive species characterized by its pale whitish yellow-drying twigs, its usually well-developed and persistent indumentum, its terminal inflorescences, and its ellipsoid, deeply wrinkled fruits with a furfuraceous surface and a very thin-walled stone. The epithet *rubiginosum* ("rusty") is very appropriate since the conspicuous, rusty brown indumentum persists so long.

Although *Calophyllum rubiginosum* is superficially similar to *C. molle*, the two species keying out adjacent to one another in Henderson and Wyatt-Smith (*op. cit.*), there are numerous differences between them, and they are probably not closely related. *Calophyllum molle* has yellow latex, clearer venation, a petiole less than 1 cm. long, axillary inflorescences, flowers with four tepals and at least 500 stamens, a densely tomentose ovary, and a spherical fruit that is finely wrinkled but not furfuraceous and that has a stone with walls about 1 mm. thick. However, *C. molle* and *C. rubiginosum* are, so far as is known, the only two large-leaved species of *Calophyllum* to have hairs on the anthers. (Hairy anthers are also found in a few specimens of *C. canum*.) *Calophyllum rubiginosum* has also been confused with *C. wallichianum* (= *C. rufigemmatum*) because both have conspicuous, reddish

brown indumentum; however, there is otherwise little similarity between the two.

There is relatively little variation within *Calophyllum rubiginosum*. Some specimens from Sumatra have somewhat smaller leaves that are more or less rounded at the base of the lamina, and strongly flattened, two-angled twigs; *C. rubiginosum* usually has four-angled twigs, and the base of the lamina varies from more or less rounded to decurrent. *Grashoff* 970 (from Sumatra) has inflorescences that consist of a single, terminal flower, but in other characters it is unremarkable. Some specimens from Borneo, as well as *Sinclair* 8937, from Malaya, have indumentum that is shorter and less prominent and persistent than is typical for the species. The description of the rather remarkable linear bracts is taken from *KEP* 38507 (Malaya); whether or not the bracts are always linear is unclear.

The type collection of *Calophyllum rubiginosum*, *KEP* 1953, consists of two sheets, one with flowers and the other with fruits; they were collected at different times but in the same area. *Calophyllum rubiginosum* has been lectotypified on the flowering collection; the fruiting collection was made on May 22, 1918.

159. *Calophyllum molle* King, Jour. Asiatic Soc. Bengal, II. 59: 177. 1890; Curtis, Jour. Straits Branch Roy. Asiatic Soc. 25: 78. 1894; Ridley, Fl. Malay Penin. 1: 185. 1922; I. H. Burkill & M. R. Henderson, Gard. Bull. Straits Settl. 3: 347. 1925; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 307. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 188. 1973. TYPE: Malaya, Penang Hill, March (fl.) or June (fr.), 1888, *Curtis* 1426 (syntypes, K, SING). FIGURE 40, h, j.

Tree 12–30 meters tall, d.b.h. to 50 cm.; trunk without buttresses or spurs; outer bark pale brown to gray-yellow, shallowly and distantly fissured or with vertical lines of lenticels, hoop marked, the inner surface orange; under bark dark brown; inner bark orange-red to dark reddish brown, fibrous; latex clear yellow, not sticky (dirty colored, nonresinous); wood white, radially flecked, soft.

Twigs slightly flattened, 1.7–2.2 mm. across, obscurely 4-angled, drying yellowish or whitish, densely and persistently brown-tomentose, hairs to 0.5 mm. long; axillary innovations lacking basal scars; internodes (1–)2–6 cm. long; uppermost pair of axillary buds rounded, 1–2 mm. long, spreading; terminal bud plump to elliptic, 4–10 mm. long, with dense, brown, tomentose indumentum (hairs, FIGURE 41, n, o), underdeveloped internode 1–2.5 mm. long. Petiole 5–9 mm. long, deeply concave above, convex below, subpersistently tomentose; lamina ovate to suboblong or subelliptic, 6–18.5 by (1.5–)2.2–5 cm., shortly acute to acuminate at apex, rounded to cuneate and subcucullate at base, undulate and narrowly recurved at margin, thinly coriaceous, drying cinnamon-drab–grayish sepia to vinaceous-hazel above and sabelline to fulvous-umber below, rather persistently tomentose on midrib above and on entire lower surface, the midrib above narrowing near base, or already narrow at base and further narrowing gradually, raised, 0.15–0.3(–0.6) mm. wide

at midpoint, below raised, rounded to striate, the venation apparent above, slightly less so below, raised, (8 to) 11 to 17 veins/5 mm., angle of divergence 70–75(–80)°. Inflorescences from foliate axils along stem, with 3 to 5 flowers, unbranched, the axis 0.5–2.9 cm. long, persistently tomentose, lowest internode 0.5–1.8 cm. long; bracts narrowly ovate, ca. 4 mm. long, soon deciduous; pedicels 4–12 mm. long, tomentose, in fruit to 1.4 cm. long and 3.5 mm. thick. Flower (?) hermaphroditic; tepals 4 (rarely 6 in terminal flowers), the outer pair ovate-oblong, 7–8.5 by 4–6 mm., short-tomentose on back (also on inner surface, at least near apex), the inner ones  $\pm$  obovate-elliptic, 7.5–9.5 by 5–6.5 mm., nearly always tomentose in band down back; stamens 510 to 580, the filaments to 5 mm. long, connate for ca. 0.4 mm., the anthers suboblong, 0.4–0.7 mm. long, rounded to subretuse at apex, with rather dense, persistent hairs to 0.3 mm. long; ovary 2–3 mm. long, tomentose, the style 2.5–3 mm. long, the stigma peltate, ca. 0.9 mm. across, 3-radiate. Fruit subspherical to ellipsoid, 2.2–3.4 by 2–2.1 cm., apiculate to acute at apex, pubescent, drying brown to orange-brown, shallowly wrinkled; outer layer detaching cleanly from stone, 2.3–3.5 mm. thick, compact; stone spherical to ellipsoid, 1.4–2.9 by 1.3–1.5 cm.,  $\pm$  obtuse at apex, the walls 1–1.3 mm. thick, sometimes with 3 shallow, longitudinal depressions running from apex, otherwise smooth, discolored area at base 5.5–7 mm. across; spongy layer thin.

DISTRIBUTION. The Malay Peninsula, possibly also western Borneo (MAP 48).

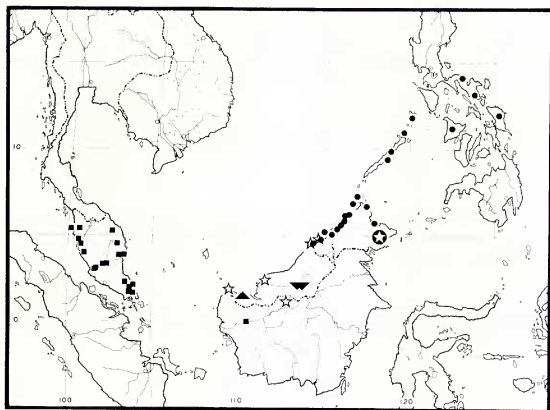
SELECTED SPECIMENS SEEN. **Malaya.** KEDAH: Gunong Inas F.R., 60 m., *KEP* 79265 (KEP). Pinang: Pulau Penang, back of W. Hill, 610 m., *Curtis* = 1426, March 1901 (K, SING). PERAK: Larut, 310–465 m., *King's collector* 6724 (BM, FL, K, P, SING); Sg. Merbau, Tapah Road, *KEP* 4563 (K, SING); Tronoh, *KEP* 12022 (KEP); Ulu Piah, *KEP* 11970 (KEP); Sungei Pangkor F.R., 36 m., *KEP* 75968 (KEP). SELANGOR: Kuang, *KEP* 14776 (KEP, P); Bukit Lagong F.R., 457 m., *KEP* 52233 (KEP, SING); Kanching F.R., *KEP* 21975 (KEP); Panjang Rawang, *KEP* 24931 (KEP). TRENGGANU: Ulu Besut, near Bukit Jebak Puyoh, 150 m., *FRI* 8285 (A, K, KEP); Ulu Sungei Loh below E. face G. Mandi Angin, 701 m., *FRI* 12135 (K, KEP). PAHANG: G. Tapis, 610 m., *FRI* 10903 (A, KEP, SAR, SING); Raub, Bilut F.R., *KEP* 23353 (KEP); Kuantan, Baloh F.R., 15 m., *KEP* 77971, *pro parte* (KEP); Temerloh, *KEP* 5458 (SING). JOHORE: Renggam F.R., 45 m., *KEP* 71274 (KEP); Mersing F.R., 15 m., *KEP* 77929 (A, BO, K, KEP, SING); Labis F.R., Ulu Endau, *FRI* 7878 (A, K, KEP, SAR, SING); NW. G. Blumut, 427 m., *FRI* 8757 (A, K, KEP, SAR, SING); Kota Tinggi, Panti F.R., *KEP* 53935 (KEP, SING). **Borneo.** KALIMANTAN. Barat: Sanggau, G. Keramas, 75 m., *bb* 14405 (?) (BO).

ECOLOGY. Mixed dipterocarp forests, often on ridges and hillsides; 15–701 m. alt. Flowering March (most) and August (once); fruiting June, July, and September to November (fruit brown).

GERMINATION AND YOUNG PLANT. The young plant is erect, and the terminal bud is functional.

*Calophyllum molle* can readily be recognized by its well-developed, tomentose indumentum; its leaf blades, which are often slightly cucullate at the





MAP 48. Distribution of *Calophyllum molle* (squares), *C. ardens* (stars), *C. aurantiacum* (erect triangle), *Calophyllum* sp. 163 (inverted triangles), *C. obliquinervium* (circles), and *C. sakarium* (star in solid circle) in Malaysia.

base; its axillary inflorescences; its flowers, which have four tepals and anthers that are more or less covered by short hairs; and its large, shallowly wrinkled fruits with a thick outer layer and a thick-walled, triradiately marked stone. The soft, tomentose indumentum of this species presumably suggested the epithet *molle* ("soft").

*Calophyllum molle* is superficially similar to *C. rubiginosum*, and both species have hairs on their anthers. However, the two are not otherwise very similar; for the differences separating them, see *C. rubiginosum*.

The report of *Calophyllum molle* from Sumatra (Ridley, *loc. cit.*; Beccari, *PS* 953—see *Calophyllum* sp. 54) is incorrect. However, *bb* 14405, from western Kalimantan, is possibly to be referred to *C. molle*. It has a terminal bud up to 1.5 cm. long, its stems dry mid-brown, its petiole is broad, and its lamina is up to 14.5 by 6.5 cm. However, in general leaf and indumentum type it is similar to *C. molle*, and its flowers have four tepals, hairy anthers, and a densely tomentose ovary.

Henderson and Wyatt-Smith (*loc. cit.*) suggested that *Calophyllum molle* was typified by *Curtis* 1426; this number and several (unspecified) numbers of King's collector (Kunstler) had been mentioned in the protolog. In the Kew and Singapore herbaria there are some specimens of *Curtis* 1426 with flowers that were collected in March (the year is not mentioned), and others

with fruits that were collected in June, 1888. Not having seen material from Calcutta, I have not designated a lectotype.

160. *Calophyllum obliquinervium* Merr. Philip. Jour. Sci. **20**: 409. 1922, Enum. Philip. Fl. Pl. **3**: 30. 1923; Keith, N. Borneo Forest Rec. ed. 2. **2**: 314. 1952; J. Anderson, Gard. Bull. Singapore **20**: 154. 1963, *pro minore parte*; Pukul & Ashton, Checklist Brunei Trees, 93. 1964, *pro parte*; Meijer, Bot. Bull. Herb. Forest Dept. Sabah **7**: 15. 1967, Field Guide Trees W. Malesia, 161. 1974. TYPE: Philippine Islands, Palawan, Feb. 1920, *FB 27929* coll. *Cenabre, Paras, & Gellidon* (isotypes, BM, UC).

*C. benjamina* Ridley, Kew Bull. **1938**: 119. 1938; Masamune, Enum. Phanerog. Born. 475. 1942; Keith, N. Borneo Forest Rec. ed. 2. **2**: 313. 1952. TYPE: Brunei, Limbang, *Haviland 505* (holotype, K; isotypes, SAR, SING).

*C. pseudotacamahaca* vel. aff. auct., non Planchon & Triana; Keith, N. Borneo Forest Rec. ed. 2. **2**: 313. 1952.

Tree 4–20(–30) meters tall, d.b.h. to 64.5 cm.; without buttresses; outer bark yellowish to grayish brown at first, with diamond-shaped fissures, becoming brown to blackish with reddish or brownish tinge, cracked or fissured, scaling, the inner surface dirty brown-greenish; under bark dark red; inner bark reddish brown to yellow; latex clear yellow (white—*SAN 33639*), very sticky.

Twigs slightly flattened, 1.2–3 mm. across, 4-angled to 4-ate, drying blackish brown, glabrous or sparsely farinose when young; axillary innovations lacking basal scars; internodes 0.5–3(–5) cm. long, terminal internode of innovation usually  $\frac{1}{2}$  or less length of others; uppermost pair of axillary buds rounded, ca. 0.5 mm. long, obscured by petiole bases; terminal bud plump, 1.5–2.5 mm. long, with rufous to pale brown, puberulent to subadpressed indumentum (hairs, FIGURE 41, k–m), underdeveloped internode not apparent. Petiole (0.3–)1–2.3 cm. long, flat to concave above, convex below, glabrous; lamina elliptic to subobovate, (3.8–)5.7–14.5 by (1–)1.2–6.5 cm., acute to acuminate and recurved at apex, decurrent to cuneate (rarely rounded) at base, slightly undulate and not recurved at margin, coriaceous, drying umber to olivaceous above, umber to fulvous below, glabrous or very nearly so, the midrib above narrowing gradually from base, margins slightly raised, adjacent midrib often slightly raised, center slightly depressed, 0.1–0.3 mm. wide at midpoint, usually disappearing ca. 1 cm. short of apex, below not much raised, rounded or  $\pm$  striate, the venation above and below subobscure, raised, 9 to 19 veins/5 mm., angle of divergence 30–50°. Inflorescences terminal and from adjacent foliate axils (rarely 2 per axil), with 7 to 13 flowers, usually unbranched, the axis 3.5–9 cm. long, glabrous, or puberulent near base when young, lowest internode 1.7–3.5 cm. long; bracts 1.5–3(–8) mm. long, soon deciduous; pedicels 0.5–1.9 cm. long, to 2.5 cm. long in young fruit, glabrous. Flower (?)hermaphroditic; tepals 8 or 10, the outer pair suborbicular, (2.3 (when 10 tepals)–)3–3.7 mm. long and across, the next pair, when 10 tepals,  $\pm$  ovate, ca. 4.5 by 3.2 mm., the inner ones obovate

to elliptic, 5–8.5 by 2.5–4.5 mm. (rarely ca. 6 by 1.5 mm.); stamens 55 to 125, the filaments to 4 mm. long, connate for up to 0.5 mm., the anthers suboblong, 0.5–1.5 mm. long, truncate to retuse at apex; ovary 1–1.5 mm. long, the style 2–4 mm. long, the stigma excentrically peltate, 0.5–0.8 mm. across, infundibular. Fruit spherical to ellipsoid, 0.9–1.3 by 0.75–1.1 cm., apiculate or not, drying dark brown,  $\pm$  smooth when ripe, strongly wrinkled when young; outer layer not detaching cleanly from stone, less than 0.5 mm. thick, air spaces developing; stone  $\pm$  spherical to ellipsoid, 6–8.5 by 5.5–7.5 mm., rounded at apex, the walls 0.2–0.3 mm. thick, smooth, unmarked; spongy layer thin.

**DISTRIBUTION.** Northeastern Borneo, never far inland, and the northern and western Philippine Islands (MAP 48).

**SELECTED SPECIMENS SEEN.** **Borneo and adjacent islands.** **BRUNEI:** Tutong, Kg. Danau, *van Niel* 3453 (L); Bukit Pasir Puteh, *BRUN* 5020 (BO, BRI, K, KEP, L, SAR, SING); Belait, mouth R. Lumut, *van Niel* 4046 (L); Lumapas, *KEP* 37223 (A, K, KEP, SING); Berakas, *KEP* 37212 (K, KEP, SING). **SABAH:** Sipitang: 2.4 km. NE. of Sipitang, 6 m., *SAN* 15191 (A, BO, K, KEP, SAN, SING); Kuala Mengalong F.R., 30 m., *SAN* 73151 (K, L, SAN, SING); Sungei Buntuh, 3 m., *SAN* 27978 (L, SAN, SAR); Marantaman, *SAN* 2492 (A, BO, K). **PAPAR:** Kawang F.R., *SAN* 30271 (K, KEP, L, SAN, SAR, SING); Kimanis F.R., 6 m., *A* 301 (K, KEP, SING); Kg. Padawan, *SAN* 30311 (K, KEP, L, SAN, SAR, SING); Bongawan F.R., 4.5 m., *SAN* 2316 (A, BO, K). **KOTA KINABALU:** Pulau Gaya F.R., 6 m., *SAN* 41303 (K, L, SAN, SING); Putatan, 1 m., *SAN* 33639 (KEP, L, SAN, SAR, SING); Penampang, *SAN* 2813 (BO, K); Bukit Padang, *SAN* 19940 (SAN). **TUARAN:** Lumas F.R., 180 m., *SAN* 33837 (K, L, SAN, SAR). **KOTA BELUD:** Kelawat F.R., 120 m., *SAN* 33644 (K, KEP, L, SAN, SAR, SING). **KUDAT:** Marudu, Kitaku F.R., *A* 1199 (A, BO, K, KEP, SING, US); Kadayan F.R., *A* 3181 (BO, BRI, KEP, L, P, SING, US); Loro F.R., 150 m., *SAN* 51054 (BISH, NY, SAN); Balembangan B., 6 m., *SAN* 69604 (SAN). **LABUK & SUGUT:** Jembongan Is., *SAN* 18956 (A, BO, K, KEP, L, SAN, SAR, SING). **SANDAKAN:** Leila F.R., Water Works, *SAN* 48174 (K, KEP, L, SAN, SAR, SING); Sepilok Trig. Hill, 90–150 m., *SAN* 24904 (K, L, SAN); Bukit Luku, Buli, *SAN* 20553 (BO, L, SAR, SING). **Philippine Islands.** **PALAWAN:** Aborlan, Malasgao R., *PNH* 14132 (A, BO, UC, US); Tapul Mt., vicinity of Puerto Princesa, *Ebalo* 534 (A, BISH, NY, UC); Silanga, *BS* 9585 (?)(K, US). **CALAMIAN:** Culion: sine loco, *Herre* 1087 (A, NY, UC). **LUZON:** Camarines Norte: Paracale, *FB* 27096 (A, K, P, US). **Albay:** sine loco, *FB* 20108 (BO). **SAMAR:** sine loco, *Philippine Plants* 1630 (BM, BO, G, GH, MO, NSW, NY, P, SING).

**ECOLOGY.** Rather variable in Borneo, although favoring poorer (acid) soils (in kerangas vegetation and similar places), by seashore, in swamps (at Kimanis), in primary forest with nibong (*Oncosperma* Blume), in secondary forest, in mixed dipterocarp forests on hillsides; to 180 m. alt. In Philippine Islands also with wide ecological range (Merrill, 1923, *loc. cit.*). Flowering December, February, and March (flower scented, petals often notably reddish or purplish—e.g., *BRUN* 5020); fruiting March to May, July, and December (fruit bluish, or reddish black).

**GERMINATION AND YOUNG PLANT.** The radicle probably breaks through the stone to one side of the base. The seedling has two pairs of leaves separated

by a well-developed internode. Subsequent growth is rather slow, but the young plants seen were growing on a dry ridge, which may have made their growth slower than normal. The young plants are erect, and the terminal bud is functional. Young plants 30 cm. tall lacked the characteristic short terminal internode on each innovation, but this was present on innovations of plants about 1.6 meters tall. (*Stevens 702*, from Sabah.)

LOCAL USE. The timber is used for building.

*Calophyllum obliquinervium* is a distinctive species. Its twigs dry dark brown, the terminal internode of each innovation is notably shorter than the others, its leaf blades have steeply ascending venation, its inflorescences are terminal and usually unbranched, and its fruits are fairly small. The epithet *obliquinervium* ("oblique nerves") was suggested by the characteristic venation of this species.

Anderson felt that *Calophyllum benjamina* and *C. obliquinervium* could be separated on bark characteristics: the bark of specimens from kerangas vegetation is gray and fissured (see his notes on *S 27681* at Kew), while that of specimens from peat swamps is yellow. Although his later reduction of *C. benjamina* to synonymy under *C. obliquinervium* (Anderson, *loc. cit.*) is correct, he included specimens of *C. ardens* in *C. obliquinervium*. *Calophyllum ardens* is a characteristic peat swamp species that apparently always has yellow bark; the numerous differences between it and *C. obliquinervium*, a species usually of drier ground, are discussed under *C. ardens*.

The similarity between *Calophyllum obliquinervium* and *C. sakarium* is only superficial, as the discussion after the latter species indicates.

Specimens of *Calophyllum obliquinervium* from Borneo are similar to those from the Philippine Islands, although the Bornean specimens have slightly smaller flowers. *Herre 1087*, from Culion Island, in the Philippines, has pedicels only 3–5 mm. long and a leaf blade that is rounded at the base; it is not otherwise different from specimens collected in the Philippine Islands.

161. *Calophyllum sakarium* P. F. Stevens

FIGURE 42, d–f.

A speciebus aliis Calophylli in lamina mediocra obovata nervis lateralibus 3 usque ad 7 per 5 mm. (in pagina superiore ut videtur 6 usque ad 14 per 5 mm.), inflorescentiis terminalibus, floribus cum 8 tepalis, et fructu 1.1–1.3 cm. longo, differt.

Tree 12–24 meters tall, d.b.h. to 65 cm.; outer bark yellowish green to yellowish white, scaly or fissured; inner bark pale red or red-brown; latex yellow.

Twigs flattened, 2–3(–3.5) mm. across,  $\pm$  strongly 4-angled, drying brown, soon glabrescent; axillary innovations lacking basal scars; internodes 1.5–3 (–4.5) cm. long, becoming shorter toward apex (uppermost internode less than  $\frac{1}{2}$  length of others); uppermost pair of axillary buds rounded, ca. 1 mm. long, spreading; terminal bud bluntly conoid, 1.4–2 mm. long, with short, brown, tomentose indumentum (hairs, FIGURE 41, h–j), underdeveloped internode 0.5–1.5 mm. long. Petiole 0.6–1.7 cm. long, shallowly concave above,

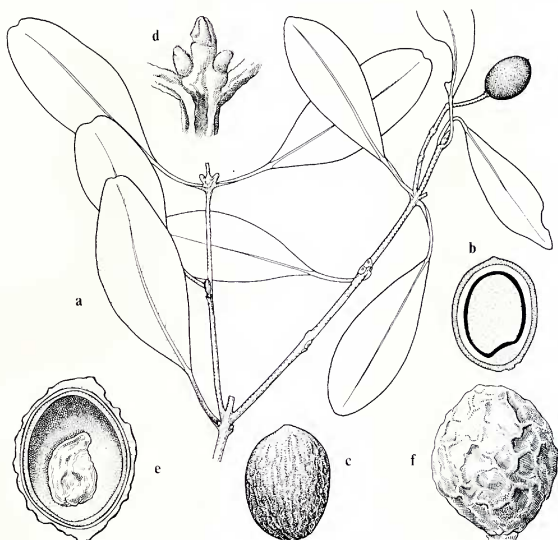


FIGURE 42. a-c, *Calophyllum ardens* (BRUN 297). a, habit,  $\times 0.5$ . b, c, fruit  $\times 0.75$ : b, longitudinal section; c, from outside. d-f, *C. sakarium*. d, SAN 57404, terminal bud,  $\times 3$ . e, f, SAN 21622, fruit,  $\times 3$ : e, longitudinal section; f, from outside.

convex below, glabrescent; lamina obovate, 4-9 by 1.7-4.7 cm., rounded to shallowly retuse at apex, cuneate to acute at base, distantly undulate but not recurved at margin, coriaceous, drying olivaceous above and sabelline below, often with grayish covering, soon glabrescent or sparsely and persistently puberulent on midrib below, the midrib above narrowed gradually from base, flat to slightly raised, 0.3-0.7 mm. wide at midpoint, below slightly raised, striate or not, the venation subobscure above and below, latex canals as prominent as veins above, 3 to 7 veins/5 mm., angle of divergence 40-55°. Inflorescences terminal and from adjacent foliate axils, with 7 to 25 flowers, terminal inflorescences flabellate and/or with branches up to 5 cm. long and with 7 flowers, axillary inflorescences unbranched, the axis (1.5-3-9 cm. long, puberulent at base, lowest internode 1.5-4.6 cm. long, frequently only 0.3 mm. in terminal inflorescences; bracts unknown; pedicels 0.7-2.5

cm. long, glabrous. Flower (?)hermaphroditic; tepals 8 (or 9), the outer pair suborbicular, ca. 3 by 3 mm., when 8 the inner ones obovate to suborbicular, 5-11 by 4-7 mm., when 9 innermost one ca. 6.5 by 3 mm.; stamens 105 to 160, the filaments to 4 mm. long, the anthers suboblong, 1.2-1.7 mm. across, retuse at apex; ovary ca. 1.5 mm. long; style ca. 3 mm. long; stigma peltate, (?)1-1.5 mm. across, 2-radiate. Fruit ellipsoid, ca. 1 by 0.8 cm., apiculate, drying vinaceous-brown, wrinkled; outer layer detaching from stone only with difficulty, 0.2-0.3 mm. thick, compact, (?)air spaces developing at maturity; stone ellipsoid, ca. 0.8 by 0.7 cm., rounded at apex, the walls 0.2-0.3 mm. thick, smooth, unmarked; spongy layer initially thick.

TYPE. Sabah, Lahad Datu, V.J.R. Silam, 240 m., 12 Dec. 1966, *SAN 57404* coll. *Sinanggol* (holotype, L; isotypes, K, SAN).

DISTRIBUTION. Borneo (southeastern Sabah), local (MAP 48).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SABAH. Lahad Datu: Pulau Sakar, 60 m., *SAN 21612* (K, KEP, L, SAN), 75 m., *SAN 21613* (K, KEP, L, SAN, SAR, SING), 6 m., *SAN 21622* (A, K, KEP, L, SAN, SAR, SING), *SAN 24569* (K, KEP, L, SAN, SING), 36 m., *SAN 26993* (A, K, KEP, L, SAN, SAR, SING); Silam, ca. 36 m., *SAN 29384* (K, KEP, L, SAN, SAR, SING); Mile 1, Silam Road, 90 m., *SAN 47686* (A, K, L, SAN); Mile 13, base of Mt. Silam, 75 m., *SAN 73422* (SAN).

ECOLOGY. Well-drained ridges or slopes, once in soil derived from ultramafic rock (*SAN 21612*); 6-240 m. alt. Flowering December, and February to April; submature fruit in April.

*Calophyllum sakarium* can be readily distinguished by its obovate leaf blades that are rounded at the apices; its steeply ascending, rather distant venation that appears to be twice as dense on the upper surface of the blade as on the lower; its terminal inflorescences; and its small, ellipsoid fruits. The specific epithet is taken from the name of an island, Pulau Sakar, where this species has been collected.

There is considerable variation in internode length along both vegetative and inflorescences axes. Although the terminal two pairs of leaves are never pseudoverticillate, as in *Calophyllum obliquinervium*, the uppermost internode may be less than half the length of the penultimate one. In addition, there is a tendency for the first internode of the axillary innovations to be notably longer than the rest. However, the basal internode of terminal inflorescences varies greatly in length and is frequently much shorter than subsequent ones.

The relationships of *Calophyllum sakarium* are obscure. Although both *C. ardens* and *C. obliquinervium* have medium-sized leaves with steeply ascending venation, and *C. obliquinervium* has terminal inflorescences, the two species are readily distinguished by the characters given above. In addition, both species have denser venation (apparently equally dense on both surfaces of the lamina); *C. obliquinervium* has leaf blades that are usually acuminate at the apices; and *C. ardens* has much larger fruit. An anatomical feature that readily distinguishes *C. sakarium* is the presence of a large latex canal replacing most of the vascular tissue in alternate vascular bundles; each

normal vascular bundle is separated by three latex canals. This feature has not been observed in any other species.

*Calophyllum sakarium* is possibly closer to *C. pentapetalum*, which also often has terminal inflorescences and small fruits. However, the latter species has an often smaller lamina that is rarely obovate in shape, denser venation (the same density on both surfaces), and hairs that are usually strongly papillate or even branched at the base.

162. *Calophyllum ardens* P. F. Stevens, sp. nov.

FIGURE 42, a-c.

*C. obliquinervium* auct., non Merr.; J. Anderson, Gard. Bull. Singapore 20: 154. 1963, *pro majore parte*; Pukul & Ashton, Checklist Brunei Trees, 83. 1964, *pro parte*; Smythies, Common Sarawak Trees, 61. pl. 21. 1965. *Calophyllum* sp. nov. J. Anderson, Trees Peat Swamp Forest Sarawak, 86. pl. 27c. 1972.

A speciebus aliis *Calophylli* in foliis patentibus, lamina elliptica valde coriacea margine plana nervis lateralibus sub angulo 25-35° e costa abeuntibus, et fructu magno circa 3 cm. longo putamine parietibus circa 1.2 mm. crassis, differt.

Tree 15-30 m. tall, d.b.h. to 45 cm.; trunk without buttresses, numerous knee roots present; outer bark ochraceous, smooth, hard, with thin, curved scales; inner bark reddish brown, lamellate, or in transverse section bright yellow with dark brown lamellae; latex bright yellow, opaque, or brown, very viscous.

Twigs flattened, 2.5-3 mm. across, not angled or obscurely so, drying brown to blackish, glabrous at maturity; axillary innovations lacking basal scars, such scars perhaps present in young plants; internodes 1.5-4.5 cm. long; uppermost pair of axillary buds rounded, to 1 mm. long, spreading; terminal bud plump, 4.5-6 mm. long, with crustaceous, brown indumentum (hairs, FIGURE 41, aa), underdeveloped internode absent. Petiole 2-2.8 cm. long, broadly concave above, convex below, glabrous; lamina elliptic or cuneiform to obovate, 4.5-8.5(-10.7) by 1.7-4.6 cm., retuse or rounded to acute at apex, narrowly cuneate at base, quite flat at margin, very coriaceous, drying honey above and sabelline below, glabrous, midrib above narrowing gradually from base, flat to slightly depressed, surrounding lamina obscurely raised, (0.25-)0.4-0.6 mm. wide at midpoint, disappearing ca. 1.2 cm. below apex, below  $\pm$  flat, not conspicuous, the venation inconspicuous on both surfaces, slightly raised, 5 to 10 veins/5 mm., angle of divergence 25-35°. Inflorescences from foliate axils, with scars of 7 to 14 flowers, sometimes with 3-flowered branches to 1.6 cm. long, the axis 3.5-6 cm. long, glabrous, lowest internode 0.7-2 cm. long; bracts unknown; pedicels in fruit (0.2-)1.5-2 cm. long, glabrous. Flower not known. Fruit ellipsoid, 2.7-3 by 2-2.2 cm., subrounded at apex, drying brown, inconspicuously striate; outer layer detaching cleanly from stone, ca. 0.8 mm. thick, compact, hard; stone ellipsoid, ca. 2.6 by 1.95 cm., obtuse at apex, the walls ca. 1.2 mm. thick, smooth, unmarked, paler area ca. 6 mm. across at base; spongy layer thin.

TYPE: Brunei, Tutong, Bukit Pasir Puteh, 1.5 m., 25 July 1957, *BRUN* 297 coll. *Ashton* (holotype, L; isotypes, BO, BRI, KEP, SAR, SING).

DISTRIBUTION. Northern and western Borneo, scattered (MAP 48).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 3rd Division: Loba Kabang South Protected Forest, S 659 coll. *Anderson*, 12 Jan. 1954 (KEP, SAR, SING), KEP 79327 (A (frag.), KEP). BRUNEI: Telamba, KEP 37081 (KEP); Badas, KEP 48498 (KEP). KALIMANTAN. Barat: Kenepai, *Teymann*, HB 8050 (BO); Sambas, Paloh, 5 m., bb 13885 (BO).

ECOLOGY. Low-altitude peat swamps; rare in alan forest (*Shorea albida*-*Gonostylus-Stemonurus* association), more common in *Shorea albida*-dominated forest, locally abundant in *Shorea albida*-*Litsea-Parastemon* association (*Anderson*, 1963, *op. cit.*); below 5 m. alt. Fruiting in July.

LOCAL NAME AND USE. An Iban name, "kayu api," means "firewood." "The yellow exudate of the tree is richly secreted into the outer bark, imparting to it its color, and the flakes infused with dry sap ignite easily, burning with a smoky yellow flame. Hence its use in firelighting" (*BRUN* 297).

*Calophyllum ardens* is a very distinctive species, immediately recognizable even when sterile by its spreading leaves and by its very coriaceous leaf blades that dry quite flat and have steeply ascending venation. The epithet *ardens* ("burning") is appropriate since the bark is used to start fires.

Although both *Calophyllum ardens* and *C. obliquinervium* have been collected at Bukit Pasir Puteh in Brunei (the latter as *BRUN* 5020) and have been much confused in the literature, they are easily separable. The leaf blades of *C. obliquinervium* have steeply ascending veins similar to those of *C. ardens*, but they are less coriaceous, and the leaves themselves are more or less ascending on the twigs. *Calophyllum obliquinervium* has terminal, not axillary, inflorescences; its fruits are about one-third the size of those of *C. ardens* and have a thin-walled stone. *Calophyllum ardens* is a characteristic tree of peat swamps, but *C. obliquinervium* is very rare there; references to the latter occurring in peat swamps (e.g., Whitmore, 1975, p. 153) usually refer to *C. ardens*. There are anatomical differences, the most obvious being the thickness of the cuticle/epidermal cell wall complex; 25-35  $\mu$ m. on both leaf surfaces in *C. ardens*, and less than 10  $\mu$ m. in *C. obliquinervium*.

The leaves from apparently young plants are narrowly elliptic and measure up to 12.5 by 2 cm. Axillary innovations in such specimens appear to have basal scars. (*Teymann*, HB 8050.)

### 163. *Calophyllum* sp.

FIGURE 40, m-o.

Tree 4.5-25 meters tall, d.b.h. to 48 cm.; outer bark shallowly fissured and flaked.

Twigs flattened, 1.8-2.5 mm. across, 4-angled, drying dark brown, transiently subfarinose; axillary innovations lacking basal scars; internodes (0.5-)1.2-3.5 cm. long; uppermost pair of axillary buds  $\pm$  rounded, ca. 1 mm. long, spreading; terminal bud plump to conical, 3-4.5 mm. long, with grayish brown, subcrusta-



ceous indumentum (hairs, FIGURE 43, v-x), underdeveloped internode to 3(-7) mm. long. Petiole 0.8-1.3 cm. long, deeply concave above, convex below, glabrous; lamina elliptic to suboblong, 4.8-12.5 by 1.8-4 cm., acute to subacuminate at apex, acute to attenuate at base, undulate and slightly recurved at margin, coriaceous, drying hazel to olive above and fulvous below, sparsely farinose-puberulent on midrib below when young, the midrib above narrowing gradually from base, raised, 0.12-0.2 mm. wide at midpoint, below raised,  $\pm$  angled to substrate, the venation subapparent above and below, raised, latex canals sometimes subimpressed on both surfaces, 6 to 11 veins/5 mm., angle of divergence 70-80°. Infructescences from foliate axils, with scars of 7 to 11 flowers, unbranched, the axis 2-4.7 cm. long, glabrous, lowest internode (0.2-)0.4-1.2 cm. long; bracts unknown; pedicels 0.7-1.8 by 1.2-1.5 mm., glabrous. Flower unknown. Fruit spherical, ca. 1.2 by 1.2 cm., apiculate or not, drying kaiser brown, sharply wrinkled; outer layer detaching cleanly from stone, 1.3-2 mm. thick, compact; stone subspherical, ca. 10 by 9 mm., rounded at apex, the walls ca. 0.15 mm. thick, smooth, unmarked; spongy layer thick at first.

DISTRIBUTION. Northeastern Sarawak, (?)Brunei (MAP 48).

SPECIMENS SEEN. **Borneo.** SARAWAK. 3rd Division: Balleh, Ulu Mujong, Temiai/Temalad watershed, 1100 m., *S* 13399 (A, K, KEP, SAN, SAR, SING); Carapa Pila, Ulu Mujong, Balleh, 900 m., *SAN* 19958 (A, BO, K, KEP, SAN, SAR, SING); Ulu Pila/Mujong watershed, 850 m., *S* 19612 (A, K, KEP, SAN, SAR, SING); Kapit, Melinau, Bukit Mabong area, 1006 m., *S* 25796 (SAR). BRUNEI: G. Pagon Periok, 1500 m., *BRUN* 1372 (?) (SAR). Sine loco: *S* 10634 (SAR).

ECOLOGY. Locally common in lower montane forest on basalt or dacite, 900-1500 m. alt. Fruiting in April; fruit green.

*Calophyllum* sp. 163 can be recognized by its short, subconoid terminal bud often with an obvious underdeveloped internode; its inconspicuous indumentum; its more or less elliptic leaf blades that dry bicolored (hazel to olivaceous above, fulvous below); and its spherical, wrinkled fruit with a compact outer layer 1.3-2 mm. thick.

Because of the way it dries, *Calophyllum* sp. 163 is superficially similar to some members of the *C. blancoi* complex, but its short terminal bud and unbranched hairs readily distinguish it. *Calophyllum incumbens* also tends to dry a similar color to *Calophyllum* sp. 163, but that species has a different terminal bud and fruit (cf. FIGURES 40, m-o, and 32, a, b). *Calophyllum tetrapterum* var. *obovale* may have a terminal bud somewhat similar to that of *Calophyllum* sp. 163, but its obovate leaves have an obvious thickened margin, and the fruits are usually smaller and have a much thinner outer layer.

*BRUN* 1372 possibly does not belong here; it is a sterile specimen, and the terminal bud does not have an obvious underdeveloped internode. On the sheet of *S* 10634 at Kuching the number and other data are in Brunig's handwriting, but the adjacent numbers were collected by Smythies on Mt. Kinabalu, Sabah.

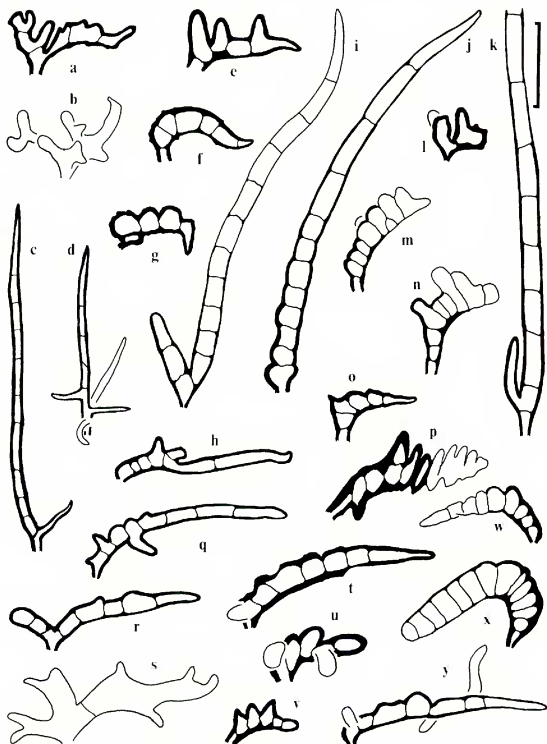


FIGURE 43. Hairs (from terminal bud, unless otherwise noted). a, b, *Calophyllum piluliferum* (LAE 51772). c, d, *C. acutiputamen* (Brass 28325). e-h, *C. leptocladum*: e, f, A. C. Smith 7874; g, h, FDA 142. i, j, *Calophyllum* sp. 151 (Stevens et al. 112). k, *C. gracillimum* (SFN 28998), base of hair ca. 600  $\mu$ m. long. l, *C. aureo-brunescens* (Ridley 16015). m-o, *C. griseum*: m, o, S 24648; n, S 15872. p, *C. aureum* (Chew 860). q-s, y, *C. whitfordii*: q, r, y, Williams 639, large hairs; s, PNH 39394, from inflorescence axis. t, u, *C. rigidulum* (BS 45686). v-x, *Calophyllum* sp. 163: v, w, S 19612; x, S 13999. Scale = 60  $\mu$ m. (in c, d, scale = 120  $\mu$ m.).

164. *Calophyllum* sp.

Tree ca. 10.5 meters tall, d.b.h. ca. 28 cm.; trunk and bark unknown.

Twigs flattened, 1–1.3 mm. across, 4-angled, drying brown, farinose when young; axillary innovations lacking basal scars; internodes 0.5–3 cm. long; uppermost pair of axillary buds rounded, ca. 0.5 mm. long, spreading; terminal bud plump to narrowly conical, 1.3–2 mm. long, with subcrustose to subpuberulent, brown indumentum, underdeveloped internode 1–6 mm. long. Petiole 4–6.5 mm. long, deeply concave above, convex below, glabrous; lamina elliptic, 4.1–6.7 by 1.3–2.7 cm., acuminate at apex, cuneate at base, slightly undulate and barely recurved at margin, thinly coriaceous, drying ± sabelline above and below, glabrous when mature, the midrib above gradually narrowed from base, raised, strongly sulcate at first, ca. 0.2 mm. wide at midpoint, below raised, rather inconspicuous, obscurely angled, the venation apparent above, subobscure below, raised, 13 to 18 veins/5 mm., angle of divergence 65–70°. Inflorescences from foliate axils, with 5 to 7 flowers, unbranched, the axis 0.3–1.2 cm. long, glabrous, lowest internode 1.5–7 mm. long; bracts unknown; pedicels 7–8 mm. long, glabrous. Flower (?) hermaphroditic; tepals 8, glabrous, the outer pair suborbicular to broadly ovate, 4–4.5 mm. long and across, only slightly concave, inner ones obovate, 6–7 by 2.5–3.5 mm.; stamens ca. 230, the filaments to 5 mm. long, the anthers elliptic, 0.25–0.3 mm. long, subapiculate to subretuse at apex; ovary ca. 1 mm. long, the style ca. 3.7 mm. long, the stigma peltate, ca. 0.7 mm. across, (?) radiate. Immature fruit ovoid, 7 mm. by 4 mm., apiculate.

DISTRIBUTION. Sarawak (MAP 47); known only from a single specimen.

SPECIMEN SEEN. BORNEO. SARAWAK. 3rd Division: Anap, Bukit Mersing, 800 m., S 22125 (K, SAR).

ECOLOGY. Mixed dipterocarp forest on basalt hillside, ca. 800 m. alt. Flowering in September.

*Calophyllum* sp. 164 can be recognized by its small, slender terminal bud, which may be nonfunctional, and its almost equally long and slender underdeveloped internode. Its elliptic leaves have fairly dense venation more prominent above than below, and its flowers have very small anthers.

165. *Calophyllum gracilipes* Merr. Philip. Jour. Sci. C. 5: 197. 1910, Enum. Philip. Fl. Pl. 3: 79. 1923. TYPE: Philippine Islands, Mindanao, Zamboanga Province, Port Banga, 600 m., 3 Feb. 1908, FB 9405 coll. Whitford & Hutchinson (isotypes, K, LY, US).

*C. tetragonum* Merr. Univ. Calif. Publ. Bot. 15: 199. 1929; Masamune, Enum. Phanerog. Born. 476. 1942; Keith, N. Borneo Forest Rec. ed. 2. 2: 315. 1952 ("C. sp. cf. *tetragonum*"); Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 15. 1967. TYPE: Borneo [Sabah], near Sandakan, Sapajaya River, 10 m., 21 March 1923, D. D. Wood 1312 (holotype, UC; isotypes, A, BO).

*C. tetragonum* Merr. var. *parvifolium* Merr. Univ. Calif. Publ. Bot. 15: 199. 1929; Masamune, Enum. Phanerog. Born. 476. 1942. TYPE: Borneo

[Sabah], Elphinstone Province, Tawao, *Elmer 21577* (lectotype, UC; isolectotypes, A, BISH, BM, C, F, G, GH, K, M, MO, NY, P, SING, U).

*C. cuspidatum* Ridley, *Kew Bull.* 1938: 119. 1938; Masamune, *Enum. Phanerog. Born.* 475. 1942. TYPE: Sarawak [4th Division], Baram, March 1895, *Hose 37* (holotype, K; isotypes, BM, L).

*C. pulcherrimum* auct., non Wall. ex Choisy; Merr. *Bibl. Enum. Born. Pl.* 393. 1921; Masamune, *Enum. Phanerog. Born.* 476. 1942.

Tree (rarely shrub), 3.7–24 meters tall, d.b.h. to 30(?–60) cm.; trunk without buttresses (rarely with short, spreading spurs); outer bark yellowish or orange-brown (brown), smooth or finely cracking and scaling, hoop marked or not, the inner surface bright orange (rarely blackish or reddish (in Sabah)); under bark red; inner bark red to pale red; latex whitish- or grayish-brown to lemon yellow, not very sticky (rarely clear yellow, sticky).

Twigs somewhat flattened, 0.6–2.5 mm. across, strongly 4-angled when young, soon becoming rounded (rounded), often with obscure horizontal lines at nodes, drying yellowish, greenish, or brown, glabrous or transiently farinose to puberulent; axillary innovations lacking basal scars; internodes 0.5–4 cm. long; uppermost pair of axillary buds rounded to pointed, to 1 mm. long, erect to spreading, often inconspicuous; terminal bud narrowly conical, 1–6 mm. long, with brownish, crustaceous to adpressed (short-tomentose) indumentum (hairs, FIGURE 41, p-r, bb, cc), underdeveloped internode to 1 mm. long. Petiole (0.2–)0.35–1.4(–2.4) cm. long, deeply concave above, convex beneath, usually glabrous; lamina narrowly elliptic or elliptic to ovate (subobovate), (2.5–)4–14(–16) by (0.75–)1.3–5.4(–6.2) cm., acuminate to long-acuminate at apex, narrowly to broadly cuneate (rarely acute) at base, strongly and closely undulate and narrowly recurved at margin, thinly coriaceous, drying umber to sepia above and fulvous to grayish below, midrib often yellowish, glabrous or shortly and subpersistently brown-pubescent on midrib below, the midrib above narrowing gradually from base, raised, center often  $\pm$  sulcate, 0.15–0.3 mm. wide at midpoint, below raised to almost flat, rounded to striate, the venation subapparent above and obscure to subapparent below, raised, latex canals below raised or depressed (additional obliquely ascending latex canals near base), 6 to 12 veins/5 mm., angle of divergence 50–70(–75)°. Inflorescences from foliate axils (sometimes 2 together), with 3 (to 9) flowers, unbranched, the axis 0.5–3(–5) cm. long, farinose to subtomentose near base, lowest internode 0.3–1 cm. long; bracts not seen, apparently caducous; pedicels 0.5–1.5 cm. long, glabrous, in fruit to 4.3 cm. by 1.5 mm. Flower (?)hermaphroditic; tepals (?4 to) 8 (to 10), glabrous or almost so, the outer pair ovate, 4.5–5.5 by 3–4.3 mm., the inner ones oblong, elliptic, or obovate, 6.5–8 by 3.5–6 mm.; stamens 60 to 110, the filaments to 5.5 mm. long, connate for up to 0.75 mm., the anthers suboblong, 0.4–0.9(–1.2) mm. long, shallowly retuse at apex; ovary 1.3–2 mm. long, the style 4.5–6 mm. long, the stigma subpeltate, apparently asymmetrical, 0.5–0.8 mm. across. Fruit subspherical, 1.3–2 cm. by 1.2–2 cm., apiculate or not, furfuraceous, drying  $\pm$  brown, broadly wrinkled; outer layer detaching cleanly from stone, 0.6–1.5 mm. thick, air spaces developing under skin and next to stone, otherwise compact; stone subovoid to ellipsoid, 1–1.4 by 0.8–1.15 cm., rounded to

apiculate at apex, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Borneo and Mindanao (Map 46).

SELECTED SPECIMENS SEEN (for explanation of letters, see text). **Borneo.** SARAWAK. 1st Division: G. Gading, 640 m., *S* 34645 (A, SAN, SAR); G. Buri, 75 m., *S* 36700 (SAR); Sabal Tapang, 175 m., *Stevens et al.* 179 (A); G. Matang, 610 m., *Stevens et al.* 270 (A). 3rd Division: Kapit, Bukit Raya, 600 m., *S* 23910 (A, BO, K, SAR, SING); Kapit, Balleh, Sungei Mengiong, *S* 29682 (A, E, K, SAR, SING); Bukit Goran, 420 m., *S* 36259 (SAR); Bukit Bukar, near Takalit, Katibas, 740 m., *S* 36398 (SAR). 4th Division: Ulu Mayeng, Kakus, 60 m., *S* 21841 (y) (A, BO, KEP, P, SAN, SAR, SING); Bukit Mersing, Anap, 150 m., *S* 21903 (y) (A, K, KEP, SAN, SAR, SING). 5th Division: Limbang, Ulu Medamit, 305 m., *S* 32327 (BO, K, SAN, SAR, SING). **BRUNEI:** Labi Hills, F.R., *KEP* 48124 (KEP). **SABAH.** Sipitang: Mensapol, *SAN* 65998 (L, SAN). Kota Kinabalu: Gaya Is. below trig., Jesselton side, 60 m., *SAN* 33559 (K, KEP, SAN, SAR, SING). Kota Belud: Bukit Matindok, 12.6 km. from Kota Belud, 310 m., *SAN* 32182 (L, SAN, SAR); Mt. Templer F.R., SW. of Sungei Talupit, 457 m., *SAN* 76245 (K, SAN, SAR). Tenom: G. Lumaku F.R., W. of Sapong Est, *SAN* 43154 (K, KEP, L, SAN, SAR, SING); Pangi, 8 km. WNW. of Tenom, 579 m., *SAN* 15115 (A, BO, KEP, SAN, SING); Mile 79, Pangi, 150 m., *SAN* 50471 (SAN). Ranau: Mt. Kinabalu, E. shoulder, 762 m., *RSNB* 209 (A, B, BO, CANB, K, L, SAN, SING), Lohan, 1372 m., *SAN* 44653 (K, L, SAN, SAR, SING); half way between Tambunan and Keninguan, 732 m., *KEP* 80422 (KEP); along Mamut road, E. of Mamut camp, 900–1400 m., *Kokawa & Hotta* 5943 (SAN). Labuk & Sugut: Telupid, S. of Agricultural Station, 60 m., *SAN* 53625 (SAN); Ulu Sungei Segualid Lokan F.R., mile 41 Labuk Road, *SAN* 72628 (K, SAN). Sandakan: Sepilok F.R., 10 m., *SAN* 16206 (A, KEP, SING); Sekong Kechil, Sepagaya, Sandakan Bay, 27 m., *SAN* 38239 (K, L, SAN, SAR, SING); Talong Tingod, Lagsikan F.R., 90 m., *A* 3409 (K, KEP, L, SING); Dusun, 60 m., *SAN* 77366 (SAN). Kinabatangan: Lamag, Bukit Garam, 36 m., *SAN* 36563 (K, L, SAN, SING); Sungei Pin V.J.R., *SAN* 52041 (SAN). Lahad Datu: Bukit Pintasan, Ulu Segama, *SAN* 79109 (SAN); near Kuala Sungei Beruang, *SAN* 71040 (SAN); Mostyn, Madai F.R., 45 m., *SAN* 67748 (SAN). Tawau: near Tawau, *Elmer* 21121 (A, BISH, BM, BO, C, F, G, GH, K, M, MO, NY, P, SING, U, UC, US); Kelumpang, Balong, 30 m., *SAN* 17342 (K, KEP, L, SAN, SAR, SING); Gemok Hill, 180 m., *SAN* 39219 (K, L, SAN); Ulu Sungei Apas, *SAN* 32955 (K, L, SAN); Membalu F.R., 60 m., *SAN* 22770 (A, BO, K, KEP, SAN, SAR, SING); [Sungei] Umas-Umas, 6 m., *SAN* 4575 (K, SING). **KALIMANTAN.** Timur: Kabiran, Sungei Bengaloen, 100 m., *bb* 11657 (BO). Barat: Liang Gagang, *Hallier* 2992 (?) (A, BO, K, L); Sekadau, Pait, 250 m., *bb* 8029 (y) (BO), Tamang, 50 m., *bb* 8027 (y) (BO). **Philippines.** **MINDANAO.** Zamboanga: Sax R., *Williams* 2193 (GH, K, NY, US).

**ECOLOGY.** Mixed dipterocarp forest, to 1372 m. alt. Flowering February (Philippines), March, and July to September (flower really stamens?) sometimes yellowish or greenish; fruiting January, February, and May to November (fruit yellow to olive or brownish).

**GERMINATION AND YOUNG PLANT.** The radicle breaks the stone just to one side of the base. The seedling has two pairs of leaves separated by an internode to ca. 5 mm. long. Subsequently produced internodes are a little longer;

the terminal bud is functional; the stem is initially arched and only later straightens. (Stevens *et al.* 159, 179A, 360.)

*Calophyllum gracilipes* can be recognized by its thinly coriaceous leaf blades that are more or less undulate but slightly recurved at the margin, its few-flowered inflorescences, and its subspherical, furfuraceous fruits. The epithet *gracilipes* ("slender foot") was chosen because of the distinctive long, slender pedicels.

*Calophyllum gracilipes* is closely related to *C. aurantiacum* and *C. recurvatum*; for differences that separate *C. gracilipes* from these species, see *C. aurantiacum* and *C. recurvatum*.

*Calophyllum gracilipes* has been confused with *C. tetrapterum* var. *tetrapterum*, but the two are not closely related. In *C. tetrapterum* var. *tetrapterum* the lamina is a darker color when dry, and the margin is less prominently undulate. The flowers of the two species are similar, although *C. tetrapterum* var. *tetrapterum* has more profuse inflorescences. In fruit the two are quite different: the fruits of *C. tetrapterum* var. *tetrapterum* are about half the size of those of *C. gracilipes*, they lack a furfuraceous surface, and they have a thinner outer layer.

There is a considerable amount of vegetative variation within *Calophyllum gracilipes*, and field work is needed to understand it; ecological collections of P. S. Ashton suggest that on Bukit Raya there are two forms of this species. Specimens in the list above that are denoted by "y" have a fairly large lamina (toward the upper limits of the measurements given), the midrib on the lower surface is rather strongly raised and yellowish in color, and the veins appear to be dense because of the prominence of the latex canals. However, these characters vary individually between other specimens.

The indumentum on the terminal bud is quite variable in its development: although normally subcrustaceous to very short-tomentose, it is sometimes tomentose (e.g., S 36700, Stevens *et al.* 159; see also *Calophyllum recurvatum*).

The specimens of *Calophyllum gracilipes* from Brunei and the 3rd Division of Sarawak have slender twigs 0.6–1 mm. across, petioles 2–5 mm. long, and narrowly ovate to elliptic leaf blades 2.7–6.6 by 0.75–2(–2.7) cm. that are long-acuminate at the apex. These specimens include the type of *C. cuspidatum*, but they cannot be clearly distinguished from other specimens with larger leaves and a coarser facies.

Hallier 2992 is included only with hesitation. It has leaf blades that are rounded at the base and flowers with only four tepals. Another noteworthy specimen is SAN 33559, which has very small leaves less than 3.5 cm. long; this merely represents the lowermost extreme of great variation in leaf size within *Calophyllum gracilipes*.

The specimens determined by E. D. Merrill as *Calophyllum gracilipes* and *C. tetragonum* are very similar; in his description of the latter species, Merrill noted that its alliance was clearly with *C. gracilipes*. When described, *C. tetragonum* var. *parvifolium* was distinguished from var. *tetragonum* by small differences in leaf size; it is clear from the preceding discussion that it is impossible to recognize variants in *C. gracilipes* based on leaf size. *Calophyllum*

*tetragonum* var. *parvifolium* has been lectotypified on the sheet of *Elmer* 21577 at UC. *Elmer* 21577 and the syntype, *Elmer* 21751, are almost identical; they both agree with the protolog and have been widely distributed.

166. *Calophyllum recurvatum* P. F. Stevens, sp. nov. FIGURE 44, a, b.

A *Calophyllo* gracilipes, quo aliter simile est, in gemma terminali indumento tomentoso praedita, ramulis subulatis, ramulis, foliis, floribus et fructibus grandioribus, et lamina margine valde recurvato pagina inferiore venulis lateralibus haud conspicuis, differt.

Tree 3–20 meters tall, d.b.h. to 23 cm.; trunk without buttresses; outer bark reddish brown, brown-yellow, or grayish, sometimes mottled, with lines of lenticels, the inner surface bright orange to orange-red; under bark pale red to reddish; inner bark rose; latex yellow or clear yellow-brown, not viscous, or almost colorless and watery.

Twigs slightly flattened, 2.5–3.7 mm. across, strongly 4-angled to subulate, often with obscure horizontal lines at nodes, drying brown, glabrous or sparsely tomentose when young; axillary innovations lacking basal scars; internodes 1.5–7 mm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, erect, inconspicuous; terminal bud broadly conical, 3–6.5 mm. long, with brown, tomentose indumentum (hairs, FIGURE 41, v, w), underdeveloped internode absent. Petiole 0.8–2.2 cm. long, narrowly concave above, convex below, sometimes transiently tomentose below; lamina elliptic to suboblong, (9–)12–24 by (2.6–)3.7–9.8 cm., gradually acuminate at apex, cuneate to acute at base, rather distantly undulate and strongly but narrowly recurved at margin, coriaceous, drying sepia to gray-olivaceous above and sepia to wood-brown below, glabrous or transiently tomentose on midrib below, the midrib above narrowing gradually from base, raised, 0.2–0.35 mm. wide at midpoint, below raised, angled, the venation apparent and slightly raised above, subobscure below, 5 to 9 veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils, with 3 to 9 flowers, unbranched, flabellate, the axis (0.3–)2–6.2 cm. long, sparsely tomentose, at least at base, lowest internode 0.3–2(–4.3) cm. long (exceptionally terminal, with up to 13 flowers, branched, axis to 8.5 cm. long); bracts ovate to elliptic, 5–7 mm. long, deciduous; pedicels (0.5–)1–2.2 cm. long, glabrous, incrassate in fruit, to 3.5 mm. thick, flattened. Flower (?)hermaphroditic; tepals 8 to 12, the outer pair ovate, 5–9 by 5–7 mm., the next pair broadly elliptic, 11–12 by 8.5–9.5 mm., the inner ones narrowly elliptic to obovate, 10–12 mm. by 3.5–5 mm.; stamens ca. 125, the filaments up to 3.5 mm. long,  $\pm$  connate, the anthers oblong, 1.5–2.1 mm. long, rounded to subretuse at apex; ovary ca. 2.5 mm. long, the style 4–5.7 mm. long, the stigma asymmetric, ca. 1 mm. across. Fruit subspherical, ca. 2.3 by 2 cm., apiculate, furfuraceous, drying brown, broadly wrinkled; outer layer detaching cleanly from stone, ca. 0.7 mm. thick, large air spaces developing; stone spherical, ca. 1.3 by 1.3 cm., rounded at apex, the walls ca. 0.25 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Sarawak, 1st Division, Kuching District, 12th mile, Penrissen Road,

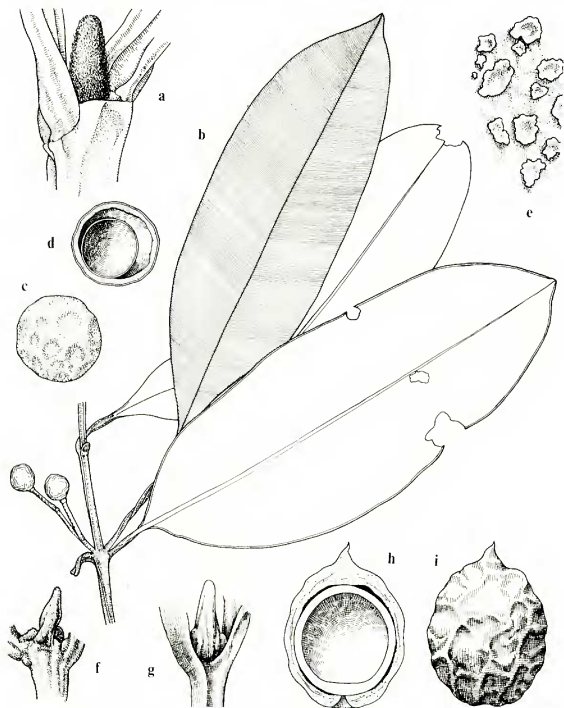


FIGURE 44. a, b, *Calophyllum recurvatum* (S 26205): a, terminal bud,  $\times 3$ ; b, habit,  $\times 0.5$ . c-f, *C. aurantiacum* (Stevens *et al.* 195). c-e, fruit: c, from outside,  $\times 1$ ; d, transverse section,  $\times 1$ ; e, surface,  $\times 25$ . f, terminal bud,  $\times 3$ . g, *C. rigidulum* (BS 45686), terminal bud,  $\times 6$ . h, i, *Calophyllum* sp. 170 (Chevalier 38909), fruit,  $\times 1$ : h, longitudinal section; i, from outside.

19 Oct. 1966, S 26205 coll. *ak Nudong & ak Bubong* (holotype, A; isotypes, K, L, SAN, SAR).

DISTRIBUTION. Borneo (MAP 47).



ADDITIONAL SPECIMENS SEEN. **Borneo and adjacent islands.** SARAWAK. 1st Division: Semengoh Arboretum, *S* 24338 (K, L, SAN, SAR, SING), *S* 25370 (K, KEP, L, SAN, SAR, SING), 90 m., *S* 7737 (BO, K, L, SAR, SING), *Stevens et al.* 143 (A); Lundu, Bukit Jebong, 60 m., *Stevens et al.* 212 (A), 90 m., *Stevens et al.* 218 (A), 120 m., *S* 15450 (BO, K, L, SAR); G. Gading, 686 m., *S* 35069 (SAR). Sine loco: *Native collector for Bur. Sci. Philip.* 641 (A, P, US), *Beccari, PB* 2304 (FI). KALIMANTAN. Timur: Bukit Liang Karing, *Jaheri* 1224 (BO); Lilibloelan Tepoetsy, *Jaheri* 882 (BO). Barat: G. Sendjudjul, 80 m., *Hamzah* 11 (BO).

ECOLOGY. Mixed dipterocarp forest, sometimes over limestone; 40–686 m. alt. Flowering August and September; fruiting September and December (fruit greenish yellow or pale green).

GERMINATION AND YOUNG PLANT. The radicle probably breaks through the stone to one side of the base. The seedling has two pairs of leaves separated by an internode less than 5 mm. long. Subsequent growth is slow, a young plant 22 cm. tall having 14 internodes in 12 cm., and although the terminal bud is functional, the stem is initially curved and straightens only after some time. (*Stevens et al.* 143.)

*Calophyllum recurvatum* can be recognized by its tomentose indumentum, subulate twigs, fairly large leaf blades with sharply recurved margins, flowers with eight to twelve tepals, and subspherical, furfureous fruits. The filaments are connate for much of their length; as a result, the androecium may remain on the old flower after the tepals have fallen—an unusual condition in the genus. The epithet *recurvatum* (“recurved”) was chosen because of the sharply recurved edges of the leaf blades.

Although *Calophyllum recurvatum* is a distinct taxon, it is not easy to decide at what rank it should be recognized. The similarity between *C. recurvatum* and *C. gracilipes* extends to the young plant (in both, the main shoot is initially curved, only later straightening) and to their somewhat similar yellowish bark. Moreover, there are three specimens more or less intermediate between the two. *S* 36700 (Sarawak, 1st Division, G. Buri, 75 m.) has a densely tomentose terminal bud and a sparsely tomentose stem and inflorescence axis, an elliptic leaf blade the size of that of *C. gracilipes* (up to 9 by 2.8 cm.) that is subpruinose below, and rather large flowers. *Stevens et al.* 159 is a sterile specimen from Gunong Matang (1st Division) with the vegetative characters of *S* 36700. *Kostermans* 6013 (Kalimantan, E. Kutei, Menubar R., NE. of Sangkulirang, 100–200 m.) has well-developed, tomentose indumentum, but in other vegetative characters (except its more or less oblong lamina) it is like *C. gracilipes*. Further collections from southwestern Sarawak and northwestern and northern Kalimantan are needed to enable a better understanding of the relationships between the two taxa.

167. *Calophyllum aurantiacum* P. F. Stevens, sp. nov. FIGURE 44, c–f.

A *Calophyllum gracilipes* et *C. recurvatum*, quibus fructibus furfureis similibus habent, in ramulis mox demum teretibus, et folio parvo coriaceo costa supra leviter vel haud elevata et ante apicem evanescenti, differt.

Sprawling shrub or tree ca. 4.5 meters tall; trunk without buttresses; outer bark yellowish (small plants) or grayish and pale brown mottled, smooth, the inner surface bright orange; under bark bright orange; inner bark pale red; latex sparse.

Twigs flattened, 1.2–2.5 mm. across, slightly 4-angled or -striate, soon becoming rounded, drying brown, soon becoming dark brown or blackish, puberulent when young; axillary innovations lacking basal scars; internodes 0.4–3.5 cm. long; uppermost pair of axillary buds rounded, to 1 mm. long, erect; terminal bud plump or conical, 1.8–3 mm. long, with short, tomentose, brown indumentum (hairs, FIGURE 41, s, y), underdeveloped internode absent. Petiole 4–11 mm. long, deeply concave above, convex below, glabrous; lamina elliptic to obovate, (2.5–)3.4–6.5(–7.7) by (1.1–)1.8–3.5 cm., rounded to subretuse at apex, cuneate toward and shortly and abruptly rounded at base, slightly to broadly and distantly undulate and recurved at margin, coriaceous, drying fulvous to olivaceous above and fulvous below, glabrous, the midrib above gradually narrowed from base, not very evident, at first subdepressed, becoming elevated, 0.05–0.15 mm. wide at midpoint, disappearing 2–4 mm. before apex, below raised,  $\pm$  angled, the venation subevident (rarely obscure) on both surfaces, slightly raised, 5 to 9 veins/5 mm., angle of divergence 50–60°. Infructescences from foliate axils, with scars of 5 to 7 flowers, not branched, the axis 0.8–1.3 cm. long, sparsely puberulo-tomentose toward base, lowest internode (0.25–)0.6–1.1 cm. long; bracts unknown; pedicels in fruit 0.6–1.1 cm. by 1.5 mm., glabrous. Flower unknown; old tepal persisting at base of fruit obovate, ca. 5 mm. by 3.5 mm. Submature fruit subspherical, 1.2–1.6 by 1–1.6 cm., rounded at apex, furfuraceous, drying brown, smooth or broadly corrugated; outer layer detaching cleanly from stone, 0.7–1 mm. thick, subcompact; stone spherical, 0.9–1.3 by 0.8–1.2 cm., rounded at apex, the walls up to 0.2 mm. thick, smooth, unmarked; spongy layer at first well developed.

TYPE: Sarawak, 1st Division, Bau, Tai Ton, ca. 105 m., 12 December 1975, *Stevens et al.* 195 (holotype,  $\alpha$ ; isotypes, SAR and to be distributed).

DISTRIBUTION. Sarawak, local (MAP 48).

ADDITIONAL SPECIMEN SEEN. **Borneo.** SARAWAK. 1st Division: Bau, Tai Ton, Bukit Numpang, 165 m., S 22784 (SAR).

ECOLOGY. Small bush or tree of limestone hills, 105–165 m. alt. Submature fruit in December.

*Calophyllum aurantiacum* can be recognized by its more or less terete twigs; its short terminal bud; its small, elliptic to obovate, rather coriaceous leaf blades; and its furfuraceous fruits. The midrib on the upper surface of the lamina is at most slightly elevated and disappears short of the apex. The epithet *aurantiacum* ("orange") was suggested by the bright orange color of the inner surface of the outer and under bark.

*Calophyllum aurantiacum* is related to *C. gracilipes* and *C. recurvatum*, two species that also have furfuraceous fruits; in all three the venation on

the underside of the fresh leaf is practically invisible. *Calophyllum aurantiacum* can be distinguished from these other species by the characters given above.

The narrow but abrupt basal rounding of the lamina develops during the drying of the specimen—living leaves of *Calophyllum aurantiacum* are cuneate at the base.

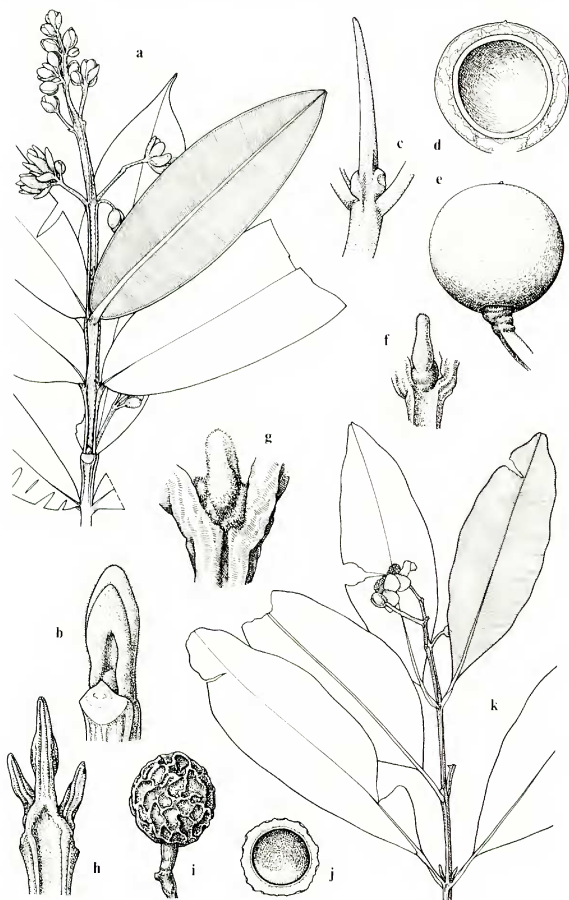
168. *Calophyllum griseum* P. F. Stevens, sp. nov.

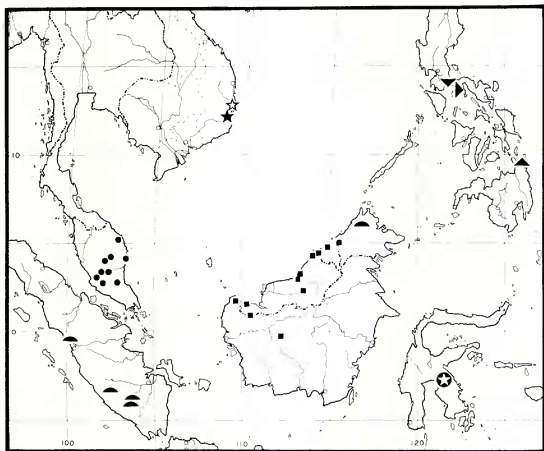
FIGURE 45, h-k.

A speciebus aliis Calophylli in lamina mediocra coriacea in siccitate supra saepe cinerascenti venulis lateralibus manifestis, inflorescentia terminali indumento farinoso-puberulento praedita, et in fructu sphaerico in siccitate rugoso putamini parietibus minoribus quam 0.2 mm. crassis, differt.

Tree 12–30 meters tall, d.b.h. to 40 cm.; trunk without buttresses; outer bark grayish brown, scaly, with scales yellowish brown and newly exposed bark dark brown (pale citrine), or deeply (shallowly—*BRUN 670*) fissured, or cracked, inner surface bright orange; under bark brownish red or dark red; inner bark brownish red or pale reddish; latex yellow, clear (yellow-green—*BRUN 670*).

Twigs slightly flattened, 1.7–3(–3.5) mm. across, usually strongly 4-angled, drying brown to yellow, brown-farinoso at first; axillary innovations lacking basal scars; internodes 1.5–5.5 cm. long; uppermost pair of axillary buds  $\pm$  pointed, 2–3.5 mm. long, spreading; terminal bud plump, 4.5–7 mm. long, with grayish, subcrustaceous indumentum (hairs, FIGURE 43, m–o), underdeveloped internode absent to 4(–7) mm. long. Petiole 0.8–1.6 cm. long, broadly concave above, convex below, glabrous; lamina ovate or suboblong to elliptic, 8.5–16 by 3.5–6.2 cm., subrounded or acute to acuminate at apex, acute to cuneate at base, broadly and deeply to barely undulate and slightly recurved at margin, coriaceous, drying sepia to gray-olivaceous above and sepia to hazel below, glabrous at maturity, the midrib above narrowing fairly quickly near base, raised, 0.2–0.4 mm. wide at midpoint, below raised, angled toward apex, striate toward base, venation  $\pm$  apparent on both surfaces, raised, 4 to 8 veins/5 mm., angle of divergence 70–80(–85)°. Inflorescences terminal and from adjacent foliate axils, with up to 20 flowers, branched, sometimes flabellate, the axis 2–4 (axillary inflorescences) or up to 9 (terminal inflorescences) cm. long, puberulent, lowest internode 1–2 cm. long; bracts unknown; pedicels 2.5–10 mm. long, puberulent, stout. Flower (?)hermaphroditic; tepals 8, the outer pair broadly ovate, 5–5.5 by ca. 4.5 mm., short-puberulent on back, the next pair subelliptic, 7.5–10 by 4–7.5 mm., sometimes puberulent toward base, inner ones oblong to elliptic, 7.5–11 by 2.5–5.5 mm.; stamens 190 to 265, the filaments to 7 mm. long, connate basally for up to 1.2 mm., the anthers oblong, 0.6–1 mm. long, apiculate to retuse at apex; ovary 1.3–2 mm. long, the style ca. 4 mm. long, the stigma peltate, ca. 0.9 mm. across, (?)4-radiate. Fruit spherical to ellipsoid, 1.7–2.2 by 1.2–1.7 cm., rounded at apex, drying dark brown; broadly wrinkled; outer layer detaching cleanly from stone, 1.7–3.2 mm. across, thick, subcompact, air spaces developing under skin; stone subspherical, 1.4–1.8 by 1–1.5 cm., rounded at apex, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer thin.





MAP 49. Distribution of *Calophyllum poilanei* (open star), *Calophyllum* sp. 170 (solid star), *C. subhorizontale* (circles), *C. exiticostatum* (half-circles), *C. griseum* (squares), *C. echinatum* (star in solid circle), *C. rigidulum* (inverted triangle), *Calophyllum* sp. 178 (side-facing triangle), and *C. brachyphyllum* (erect triangle) in Southeast Asia-Malesia.

TYPE: Sarawak, 4th Division, Bintulu, Nyabau catchment area, 100 feet [30 m.], 22 June 1966, *S* 24614 coll. *ak Luang* (holotype,  $\alpha$ ; isotypes,  $\kappa$ , KEP, L, SAN, SAR, SING).

DISTRIBUTION. Northwestern Borneo (MAP 49).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 1st Division: Semengoh Arboretum, 40 m., *Stevens et al.* 131 ( $\alpha$ ); Lundu, Sungei Arok, *S* 9624 (BO,  $\kappa$ , L, SAR, SING); G. Santubong, 90 m., *Stevens et al.* 302 ( $\alpha$ ). 3rd Division: Ulu Rejang, *FA* 515 coll. *Egon*, 4 Aug. 1938 (KLU, SAR). 4th Division: Miri,

FIGURE 45. a, b, *Calophyllum poilanei* (Poilane 6572): a, habit,  $\times 0.5$ ; b, terminal bud,  $\times 3$ . c, *C. echinatum* (Cel./II-215),  $\times 1.5$  (axillary buds knocked off). d-f, *C. exiticostatum* (bb 31756). d, e, fruit,  $\times 3$ : d, longitudinal section; e, from outside. f, terminal bud,  $\times 6$ . g, *Calophyllum* sp. 178 (FB 30772), terminal bud,  $\times 3$ . h-k, *C. griseum*. h, *S* 15872, terminal bud,  $\times 3$ . i, j, *S* 15872, fruit,  $\times 1$ : i, from outside; j, transverse section. k, *S* 25802, habit,  $\times 0.5$ .

near Sungei Dalau F.R., *KEP 80069* (KEP); Bintulu, Simalajau F.R., *S 15872* (A, BO, K, L, SAN, SAR, SING); Nyabau catchment area, 120 m., *S 24648* (A, K, KEP, L, NY, SAN, SAR). BRUNEI: Berakas F.R., 60 m., *S 2035* (?) (SAR); Anduki F.R., 3 m., *S 2243* (SAR); Labi Hills, Bukit Teraja, Mile 19¼, 150 m., *BRUN 670* (BO, BRI, K, KEP, L, SAR, SING); Labi, *KEP 30474* (A, KEP, SAR). SABAH. Beaufort: Lumat, *SAN 25802* (BO, K, KEP, L, SAN, SAR, SING). KALIMANTAN. Barat: Melawi Tjatit, B. Bansa, 400 m., *bb 26445* (BO, L); Melawi, B. Watas Emang nabij Ng. Betoeng, 175 m., *bb 26869* (?) (L).

**ECOLOGY.** Well-drained mixed dipterocarp forest, 3–400 m. alt. Flowering March, June, July, and September (flower scented); fruiting December, January, and August (fruit pale grayish brown).

**GERMINATION AND YOUNG PLANT.** Young plants about 1 meter tall are erect and have a functional terminal bud; the internodes are well developed. The young plants are conspicuous because of their pale, yellowish white bark.

*Calophyllum griseum* is a distinctive species. The upper surface of the lamina often has a grayish, waxy covering that is later rubbed off; this grayish covering suggested the specific epithet. The lamina is fairly coriaceous, with distinct and rather distant venation; the inflorescence is terminal and puberulent, and the pedicels and the backs of the outer tepals are also puberulent; the flower has eight tepals; and the broadly wrinkled fruits have a thick, subcompact outer layer and a thin-walled stone.

169. *Calophyllum subhorizontale* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 325, pl. 11. 1956; T. C. Whitmore, Tree Fl. Malaya **2**: 170. 1973. TYPE: Malaya, Pahang, Kuala Lipis, 500 feet [150 m.], *KEP 658* coll. Carroll (holotype, SING; isotype, KEP).

Tree 6–8 meters tall, d.b.h. to 29 cm.; outer bark ochre, smooth, to purplish or yellowish, fissured; inner bark reddish to white; latex yellow, sticky.

Twigs flattened, 3.5–7 mm. across, with (2 or) 4 (or 6) prominent rounded lines, drying shiny, brown when young (yellowish when older), at first puberulent; axillary innovations (?) lacking basal scars; internodes (0.5–)1–5 (–7.5) cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, suberect; terminal bud plump to conical, 4–7 mm. long, with brown, short, tomentose indumentum (hairs, FIGURE 46, 1, m), underdeveloped internode absent. Petiole 0.5–1.6 cm. long, broadly concave above, convex below, glabrous when mature; lamina elliptic to suboblong or obovate, 10.5–27 by 5.5–9 cm., obtuse to acute at apex, acute at base, distantly undulate and slightly recurved at margin, coriaceous, drying sepia above and amber to sabelline below, ± puberulent on midrib below when young, the midrib above narrowing gradually from or rather quickly near base, raised, 0.3–0.7 mm. wide at midpoint, below raised, angled, the venation above ± apparent, finely raised, below ± apparent to subobscure, broadly raised, 3 to 6 veins/5 mm., angle of divergence 65–85°. Inflorescences from foliate axils, with 7 to 9 flowers, unbranched, the axis (1–)2–4 cm. long, sparsely tomentose near base, lowest internode (0.3–)1–1.7 (–2.5) cm. long; bracts ovate, to 4 mm.

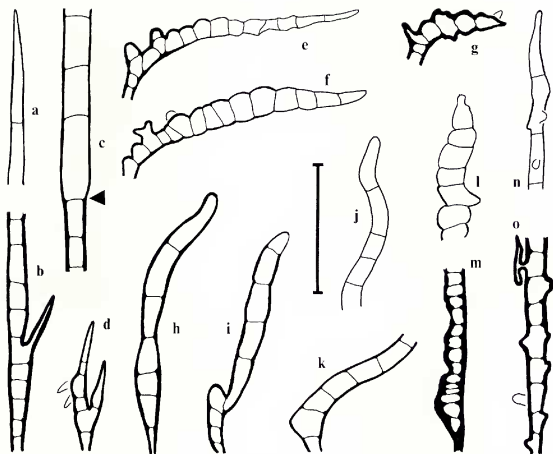


FIGURE 46. Hairs (from terminal bud, unless otherwise noted). a-d, *Calophyllum insularum*. a-c, bb 30965: a, b, apex and base of hair ca. 780  $\mu$ m. long; c, base of hair ca. 420  $\mu$ m. long, arrow marks abrupt transition in cell type. d, bb 30937. e-g, *C. exiticostatum*: e, g, bb 2299; f, Stevens et al. 559, slight birefringence. h, i, *C. membranaceum* (Wang 449). j, k, *C. poilanei* (Poilane 6572), apex and base of hair ca. 780  $\mu$ m. long. l, m, *C. subhorizontale* (KEP 94773), apex and base of hair ca. 720  $\mu$ m. long. n, o, *Calophyllum* sp. 170 (Chevalier 38909), apex and base of hair ca. 780  $\mu$ m. long. Scale = 120  $\mu$ m.

long, caducous; pedicels 1-3.5 cm. long, glabrous, in fruit to 4 cm. by 3 mm. Flower (?)hermaphroditic; tepals (8 to) 12, sometimes glabrous, the outer pair orbicular to broadly elliptic, 7-12 by 7-10 mm., the inner ones elliptic to oblong, 13-17 by 4.5-11 mm.; stamens (?)150 to 260, the filaments 4-7.5 mm. long, connate for up to 0.7 mm., the anthers oblong, 1-1.9 mm. long, rounded to slightly retuse at apex; ovary ca. 2 mm. long, the style ca. 7 mm. long, the stigma peltate-infundibular, ca. 1.7 mm. across, obscurely radiate. Fruit ovoid, ca. 4.3 by 2.5 cm., acute at apex, drying vinaceous-brown, wrinkled; outer layer not detaching cleanly from stone, 1.5-3 mm. thick, compact; stone ellipsoid, ca. 2.4 by 1.9 cm., rounded at apex, the walls ca. 1 mm. thick, smooth, unmarked; spongy layer (?)thin.

DISTRIBUTION. Malay Peninsula (MAP 49).

SELECTED SPECIMENS SEEN. **Malaya.** SELANGOR: Sungei Buloh F.R., *KEP 5315* (KEP, SING). NEGRI SEMBILAN: G. Angsi F.R., *KEP 23817* (KEP, SING). TRENGGANU: Sungei Tong F.R., *KEP 94773* (A, KEP, L, SAN, SING); Kemaman, Bukit Kajang, 150 m., *Corner s.n.*, 25 NOV. 1935 (SING). PAHANG: Sungei Tembeling, near Kuala Keniyum, Sungei Redab, 240 m., *FRI 8584* (K, KEP, L, SING); Bukit Goh F.R., *KEP 17316* (KEP); Raub, Bilut Reserve, *KEP 23381* (KEP, SING); Kuala Lipis, *KEP 1267* (KEP, SING); Lesong F.R., 45 m., *FRI 19825* (K, KEP); sine loco, *KEP 1151* (KEP).

ECOLOGY. Sometimes in rocky stream beds (*FRI 8584*), 45–240 m. alt. Flowering March and August (flower scented); fruiting March and December.

*Calophyllum subhorizontale* is a distinctive species that can be recognized by its relatively small, tomentose terminal bud; stout, more or less shining twigs; large, coriaceous leaf blades with distant venation; large flowers usually with more than eight tepals; and ovoid fruits. The tepals tend to persist at the base of the fruit. The fruit dries wrinkled and has a moderately thick outer layer and a well-developed stone. The epithet *subhorizontale* was suggested by the clear and widely ascending venation of this species.

An incomplete specimen from Vietnam, *Chevalier 38909*, has fruits superficially similar to those of *Calophyllum subhorizontale*, but the leaf blades, with their fine venation, are reminiscent of those of *C. soulattri*. At least the outer pair of tepals is densely puberulent on the back, and the outer layer of the fruit is only ca. 1.2 mm. thick and is notably fibrous (see *Calophyllum* sp. 170).

The data for the type locality and collector were kindly confirmed by K. M. Kochummen; the collector's name on the Singapore sheet is given as Phillips.

#### 170. *Calophyllum* sp.

FIGURE 44, h, i.

(?)Tree; details of trunk and bark unknown.

Twigs strongly flattened, 2–3 mm. across, persistently 4-subalate, drying brown, subpersistently tomentose; axillary innovations lacking basal scars; internodes (1.3–)2–7 cm. long; uppermost pair of axillary buds rounded, ca. 2.5 mm. long, suberect; terminal bud bluntly conical, 3 to ca. (?)5 mm. long, with brown, tomentose indumentum (hairs, FIGURE 46, n, o), underdeveloped internode absent. Petiole 1.1–2 cm. long, broadly concave above, convex below, glabrous when mature; lamina oblong to elliptic, 9–13 by 5.8–7 cm., retuse to shortly and abruptly acuminate at apex, acumen ca. 4 mm. long, acute at base, undulate and slightly recurved at margin, coriaceous, drying near sabelline above and below, subpersistently tomentose on midrib below, the midrib above narrowing quickly near base, raised, 0.3–0.4 mm. wide at midpoint, below raised,  $\pm$  angled, the venation above and below subapparent, raised, 10 to 16 veins/5 mm., angle of divergence 70–75°. Inflorescences unknown; pedicel in fruit 4–7 by ca. 2 mm., short-tomentose. Flower known only from remains at base of fruit; tepals ca. 16, the outer pair broadly ovate, 4.5–8 by 6–7.5 mm., puberulent on back, the next pair subelliptic, 7–12 by 7–11 mm.,  $\pm$  puberulent on back, the inner ones obovate to elliptic,



to 18 by 11 mm., sometimes puberulent in strip down back; stamens numerous, the filaments to 10 mm. long, connate for up to 2.3 mm., the anthers ellipsoid, ca. 1 mm. long, retuse at apex; ovary, style, and stigma unknown. Fruit ovoid to ellipsoid, 2.5–3 by 2.1–2.5 cm., sharply pointed at apex, beak ca. 7 mm. long, drying brown, with rather distant and shallow wrinkles; outer layer detaching  $\pm$  cleanly from stone, ca. 1.2 mm. thick, compact except for air spaces under skin, fibrous; stone ellipsoid, 2–2.4 by 1.8–2.1 cm., rounded at apex, the walls 1.1–1.4 mm. thick, at base 2.2–3 mm. thick and slightly fibrous, smooth, obscurely triradiate at apex, basal (?) plug ca. 6.5 mm. across; spongy layer thin.

DISTRIBUTION. Vietnam (MAP 49); known only from a single collection.

SPECIMEN SEEN. **Vietnam:** Nhatrang, entre Suối Ca et Suối Giầu, *Chevalier* 38909 (A, P).

*Calophyllum* sp. 170 can be recognized by its bluntly conical, tomentose terminal bud, very strongly and persistently angled twigs, rather large leaf blades with close venation, tomentose pedicels, flowers with twelve tepals (outer ones tomentose on back), and large, ovoid, beaked fruits with thick stone walls.

*Calophyllum* sp. 170 is similar in fruit to *C. subhorizontale*, although it differs in terminal bud, twig, and leaf. In leaves it resembles *C. soulattri* but differs in terminal bud, flower, and fruit.

Although the fruits are not attached to the shoots, they nevertheless appear to belong to the specimen.

171. *Calophyllum brachyphyllum* Merr. Philip. Jour. Sci. 17: 290. 1920, Enum. Philip. Fl. Pl. 3: 78. 1923. TYPE: Philippine Islands, Mindanao, Surigao Province, Hegapit River, ca. 350 m., 25 April 1919, BS 34482 coll. *Ramos & Pascasio* (isotypes, A, K, P, US).

Small tree; trunk and bark not known.

Twigs slightly flattened, 1–1.5 mm. across, obscurely 4-angled, drying brown when young, grayish when older, sparsely farinose when young; axillary innovations lacking basal scars; internodes 0.8–3.5 mm. long; uppermost pair of axillary buds pointed, ca. 1.5 mm. long, erect; terminal bud narrowly conical, 3–4 mm. long, with dense, adpressed, grayish indumentum (hairs, FIGURE 41, x, z), underdeveloped internode absent. Petiole 1–2 mm. long, concave above, convex below, glabrous; lamina broadly ovate to elliptic, 1.3–2.7 by (0.85–)1–2 cm., retuse at apex, rounded to shallowly cordate at base, quite flat at margin, coriaceous, drying sepia to near sabelline above to sepia below, minutely puberulent on midrib above and below when young, the midrib above narrowing near base, becoming flat to slightly raised, margins at first  $\pm$  raised, center sulcate, less than 0.2 mm. wide at midpoint, below raised, striate, conspicuous, the venation above and below subobscure, very slightly raised, 13 to 17 veins/5 mm., angle of divergence 55–70°. Infructescences from uppermost or adjacent axils, with scars of 3 to 5 flowers, unbranched, the axis 0.5–1.8 cm. long, glabrous, lowest internode ca. 5 mm.

long; bracts unknown; pedicels 1–2.5 cm. by 2 mm., glabrous. Flower unknown. Fruit spherical, to 1.3 by 1.3 cm., rounded at apex, drying dark brown, smooth; outer layer detaching  $\pm$  cleanly from stone, 1.5–1.8 mm. thick, compact; stone spherical, ca. 1 by 1 cm., rounded at apex, the walls 0.5–0.6 mm. thick, smooth, unmarked; spongy layer at first thick.

DISTRIBUTION. Philippine Islands; known only from a single collection from Mindanao (MAP 49).

ECOLOGY. Stream-side forest, ca. 350 m. alt. (Merrill, 1920, *loc. cit.*).

*Calophyllum brachyphyllum* can be recognized by its small, coriaceous leaf blades that are retuse at the apex and more or less cordate at the base; the venation is dense. The small fruit, with its relatively very thick outer layer and stone wall, is also distinctive. The epithet *brachyphyllum* ("short leaf") alludes to the short leaves of this species.

*Calophyllum brachyphyllum* is apparently a rather isolated species. It is not close to any of the cordate-leaved taxa centered on *C. venulosum*, nor is it close to *C. pentapetalum* as Merrill originally suggested. It has small leaves and dense venation like *C. exiticostatum*, but it differs from that species in its more coriaceous leaves that have a much stronger midrib, and in its fruit (that of *C. exiticostatum* is smaller, has a thin outer layer that is disorganized by air spaces, and has thin stone walls).

172. *Calophyllum rigidulum* P. F. Stevens, sp. nov.

FIGURE 44, g.

A speciebus aliis Calophylli in lamina parva percoriacea marginibus planis costa supra subplana infra lata versus basem leviter elevata versus apicem (sub)depressa, differt.

Shrub ca. 1 meter tall; trunk and bark not known.

Twigs flattened, 1–1.5 mm. across, 4-angled, drying dark brown when young, yellowish when older, sparsely farinose-puberulent; axillary innovations lacking basal scars; internodes 0.7–2.5 cm. long; uppermost pair of axillary buds subacute, 0.5–1.5 mm. long, erect; terminal bud plump, 3–4 mm. long, with brown, crustaceous indumentum (hairs, FIGURE 43, t, u), underdeveloped internode absent. Petiole 2–5 mm. long, strongly concave above, convex below, glabrous; lamina elliptic to subobovate, 1.4–3 by 0.75–1.8 cm., rounded to slightly retuse at apex, cuneate at base, quite flat at margin, very coriaceous, drying dust color above and fulvous-umber below, when young subfarinose on and near midrib on both surfaces, the midrib above narrowed at base, at first depressed, becoming level, ca. 0.2 mm. wide at midpoint, below broad,  $\pm$  depressed toward apex, raised at base, the venation obscure on both surfaces, subdepressed below, 13 to 16 veins/5 mm., angle of divergence 55–60°. Infructescences from foliate axils along twig, with scars of 3 to 11 flowers, sometimes with 3-flowered branches ca. 4 mm. long, the axis 0.6–1.4 cm. long, sparsely puberulent, lowest internode 4–7 mm. long; bracts ovate, ca. 1.6 mm. long, deciduous; pedicels 3–6 mm. long, glabrous. Flower not known; outer pair of tepals persisting at base of immature fruit suborbicular,

ca. 2 by 2 mm., thick. Young fruit ovoid, ca. 8 mm. long, apiculate, drying brown; outer layer less than 0.3 mm. thick.

TYPE: Philippine Islands, Luzon, Tayabas Province, Mt. Alzapan, 6000 feet [1829 m.], 7 June 1925, *BS 45686* coll. *Ramos & Edaño* (holotype, A; isotypes, B, K, UC, US).

DISTRIBUTION. Philippine Islands (MAP 49); known only from the type locality.

ECOLOGY. Shrub in mossy forest, ca. 1830 m. alt.

*Calophyllum rigidulum* is a distinctive, albeit poorly known, species. The leaf blades are small, very coriaceous, and rounded to shallowly retuse at the apex, and the venation is fairly dense. On the upper surface of the blade the midrib is rather narrow and indistinct, while on the lower surface it is broad but more or less depressed. The epithet *rigidulum* means "rather rigid"—appropriate for this rigid-leaved species.

173. *Calophyllum insularum* P. F. Stevens, sp. nov.

FIGURE 40, d.

*Calophyllum* sp. A, aff. *C. caudatum* Kanehira & Hatusima, P. F. Stevens, Austral. Jour. Bot. 22: 362. 1974.

A speciebus aliis *Calophylli* in lamina chartacea 4.9–10 cm. longa et 1.1–2.5 cm. lata venatione densa, ramulo, gemma terminali, costa laminae, inflorescentia et tepalis exterioribus utrinque indumento tomentoso subpersistenti praeditis, et inflorescentiis axillaribus singulifloribus, differt.

Tree to 33 meters tall, d.b.h. 40 cm.; trunk without buttresses; outer bark dark brown, with numerous shallow fissures; inner bark brown; latex yellow, clear.

Twigs slightly flattened or not, 0.9–1.3 mm. across, not 4-angled to obscurely so, with obscure horizontal line at nodes, drying blackish, subpersistently tomentose; axillary innovations frequently with scars within 6 mm. of base; internodes 1–3.5(–7) cm. long; uppermost pair of axillary buds subacute, ca. 1.5 mm. long, erect; terminal bud narrowly conical, 5–8(–9.5) mm. long, shape obscured by dense, reddish brown, tomentose indumentum (hairs, FIGURE 46, a–d), underdeveloped internode to 1 mm. long. Petiole 0.7–1.3 cm. long, deeply concave above, convex below, subpersistently tomentose; lamina narrowly ovate to elliptic, 4.9–10 by 1.1–2.5 cm., acuminate at apex, cuneate at base, undulate and slightly recurved at margin, coriaceous, drying olivaceous to umber above and sepia below,  $\pm$  tomentose on midrib, margin, and lower surface when young, persistently so on midrib below (and margin), the midrib above abruptly narrowed at base, flat to slightly raised, 0.15–0.4 mm. wide at midpoint, sometimes sulcate, below raised, slightly angled or rounded, venation evident on both surfaces, raised, (13 to) 16 to 19 (to 22) veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils near ends of twigs, with 1 flower, unbranched, the axis 3–5 mm. long, tomentose, lowest internode 3–5 mm. long; bracts not known; pedicels 5.5–8 mm. long, tomentose. Flower known only in late bud, (?)hermaphroditic;

tepals 8, the outer pair triangular, 7.5–8.5 by 4–5 mm., concave, tomentose outside and sericeous inside, the next pair elliptic to obovate, to 7.5 by 4 mm., thinner; stamens 80 to 100, the anthers oblong, 1.3–2.3 mm. long, subretuse to apiculate at apex; ovary 1.5–2 mm. long, the style 1.5–3.5 mm. long, the stigma peltate, ca. 1.3 mm. across. Fruit not known.

TYPE: Eil. Meos Noem [Irian Jaya], Seroei, 200 m., 5 Oct. 1939, *bb 30941* (holotype, L; isotypes, A, NY, SING).

DISTRIBUTION. Papuaia, known only from islands in Geelvink Bay (MAP 45).

ADDITIONAL SPECIMENS SEEN. **Papuaia.** IRIAN JAYA. Geelvink Bay: Meos Noem, Seroei, 200 m., *bb 30937* (A, L), *bb 30944* (A, L, NY, SING), *bb 30959* (A, L), *bb 30965* (A, L), *bb 30967* (L, SING); Japen Is., Aisao, 200 m., *BW 10569* (L, LAE), *BW 10585* (L, LAE).

ECOLOGY. Colline rainforest, ca. 200 m. alt. Late bud in October.

*Calophyllum insularum* can be recognized by its tomentose indumentum, its narrowly ovate to elliptic leaf blades with dense venation, its single-flowered, axillary inflorescences, and its flowers. The flower buds are bilabiate, with the tips of the outer tepals separating early (perhaps due to the way that the specimens were dried). The outer pair of tepals has hairs on both surfaces. The epithet *insularum* ("of the islands") was chosen because this species has so far been collected only on islands.

*Calophyllum insularum* can be distinguished from *C. trachycaule*, with which some of the specimens cited above had been confused, by its more delicate facies (thinner twigs, and narrower, thinner, more pointed leaves), its solitary flowers with eight tepals, the outer two of which are hairy on both surfaces (the inflorescences of *C. trachycaule* have five or more flowers, each with four subglabrous tepals), and its anthers, which are two to three times the size those of *C. trachycaule*. There are also anatomical differences between the two (Stevens, *loc. cit.*).

The indumentum on the petiole often consists of rather scattered long hairs mixed with short ones (FIGURE 46, a–d).

174. *Calophyllum poilanei* Gagnep. ex P. F. Stevens, sp. nov.

FIGURE 45, a, b.

*C. poilanei* Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 269. 1943; Pham & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. *bang 62bis* F. 1960; Pham, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. 2: 299. fig. 1970. *Nomen invalidum*.

A speciebus aliis *Calophylli* in ramulis crassis nitidis 4-subalatis, nodis defoliatis prominentibus, et inflorescentiis terminalibus axillaribusque floribus pedicellis brevibus (usque ad 10 mm. longis) vel nullis, differt.

Small tree 3–4 meters tall, d.b.h. to 7 cm.; bark not known.

Twigs slightly flattened, 4–5 mm. across, strongly 4-angled to winged, drying

brown, shiny, sparsely tomentose when young; axillary innovations with basal scars; internodes 0.7–3.5(–5) cm. long; upper pair of axillary buds rounded, ca. 1 mm. long, spreading, not conspicuous; terminal bud conical, ca. 4 mm. long, with brown, tomentose indumentum (hairs, FIGURE 46, j, k), underdeveloped internode absent. Petiole 2–5 mm. long, broadly concave above, convex below, glabrescent; lamina oblong to subobovate, 11.7–21 by 3.7–6 cm., acuminate at apex, broadly rounded to shallowly cordate at base, slightly undulate and strongly recurved at margin, marginal thickening 0.5 mm. wide, coriaceous, drying cinnamon above and fulvous below, glabrous at maturity, the midrib above abruptly narrowed near base, becoming  $\pm$  raised, 0.2–0.5 mm. wide at midpoint, below strongly raised, angled toward apex, striate toward base, venation prominent on both surfaces, raised, 6 to 12 veins/5 mm., angle of divergence ca.  $80^\circ$ . Inflorescences terminal and from adjacent foliate axils, with numerous flowers, often flabellate, branched, branches to 2.5 cm. long, the axis to 10 cm. long, tomentose when young, 4-alate, lowest internode 1–2 cm. long; bracts ovate, ca. 7 mm. long, soon deciduous; pedicels to 5(–10) mm. long, tomentose. Flower (?) hermaphroditic; tepals 10 (rarely 11), the outer pair ovate, ca. 8 by 5–6 mm., short-tomentose on back, the inner ones elliptic to oblong, 10–15 by 3.5–7 mm., outer two with strip of indumentum down back, next two with tuft of hairs near apex; stamens 130 to 180, the filaments to 9 mm. long, the anthers oblong, 1–1.3 mm. long,  $\pm$  rounded at apex; ovary 1.2–1.4 mm. long, the style 6–8 mm. long, the stigma subexcentrically peltate, ca. 1 mm. across, 3- or 4-lobed. Fruit not known.

TYPE: Vietnam, Prov. Nhatrang, nord de Ninh-Hoa, massif de la Mère et l'Enfant, 1300 m., 18 May 1934, *Poilane 6572* (holotype, P; isotype, P).

DISTRIBUTION. Central Vietnam (MAP 49).

ADDITIONAL SPECIMEN SEEN. **Vietnam:** Nhatrang, nord de Ninh-Hoa, massif de la Mère et l'Enfant, 1300 m., *Poilane 6454* (P).

ECOLOGY. Stony ground, ca. 1300 m. alt. Flowering in May; flower scented.

*Calophyllum poilanei* is one of the most distinctive species of *Calophyllum*, with its shiny, little-branched, more or less four-alate twigs that have very prominent leaf scars. The lamina is rounded to shallowly cordate at the base, the inflorescence is terminal, and the flowers usually have ten tepals. The flowers have short pedicels or are sessile; this gives the inflorescence a distinctive appearance. Although the twigs, leaves, and flowers are very robust, the plant itself is reported to be small. The epithet commemorates E. Poilane.

Gagnepain (*loc. cit.*) seems to have been somewhat confused over the flower. He referred to bracteoles, borne just under the flower, which were ca. 12 by 5 mm. The measurements of "outer sepals" were given as 8 by 4 mm. It is possible that Gagnepain's "bracteoles" were bracts (these fall off very early—only a single one was seen) or the outer pair of tepals (in which case he may have confused their measurements with those of the next pair of tepals).

The description given above is needed because Gagnepain's description (*loc. cit.*) is in French and invalid.

175. *Calophyllum membranaceum* Gard. & Champ. Jour. Bot. Kew Misc. 1: 309. 1849; Choisy, Descr. Guttif. Inde, 43. 1849, Mém. Soc. Phys. Hist. Nat. Genève 12: 423. 1851; Walp. Ann. Bot. Syst. 2: 191. 1851; Seem. Bot. Voy. H.M.S. Herald, 368. 1857; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 290. 1862; Benth. Fl. Hongkong. 25. 1861; Forbes & Hemsley, Jour. Linn. Soc. Bot. 23: 75. 1886; Vesque, Epharmosis 2: t. 4. 1889, in C. DC. Monogr. Phanerog. 8: 551. 1893; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 275. 1943; Auct. Ic. Corm. Sin. 2: 883. 1972. TYPE: Hongkong [Mt. Victoria], *Champion s.n.* (holotype, K).
- C. bonii* Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 317. 1910; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 268. 1943. TYPE: Tonkin [Vietnam], Ninh Thai, Muong Lang, 23 April 1889, *Bon 4136* (lectotype, P).
- C. tonkinense* Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 317. 1910. TYPE: Tonkin [Vietnam], Ninh Thai, Muong Lang, 17 March 1890, *Bon 4301* (lectotype, P; isoelectotype, P).
- C. spectabile* auct., non Willd.; Hooker f. & Arnott, Bot. Beechey Voy. 174. 1883.

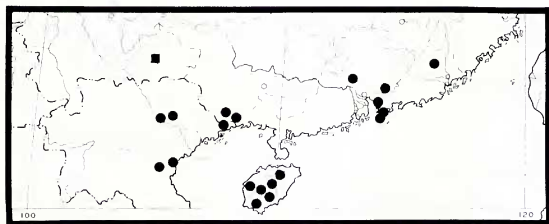
Shrub or small tree 1–5 meters tall, d.b.h. to 10 cm.; details of bark unknown.

Twigs slightly flattened, 1.3–2.5 mm. across, strongly 4-angled to subulate (with 2 additional raised lines decurrent from petiole), drying brown, glaucous when older, sparsely puberulent when young; axillary innovations lacking basal scars; internodes (0.5–)1.5–7 cm. long; uppermost pair of axillary buds pointed, to 1.5 mm. long, erect; terminal bud narrowly conical, 3.5–7 mm. long, with dense, brown, subadpressed indumentum (hairs, FIGURE 46, h, i), underdeveloped internode 0.1 mm. long. Petiole 0.4–1.4 cm. long, very deeply concave above and convex below, sparsely puberulent when young; lamina oblong to elliptic, 4.2–13.1 by 1.4–4.6 cm., acuminate at apex, cuneate at base, slightly undulate and recurved at margin, coriaceous, drying umber to olivaceous above and below, glabrous or sparsely and subpersistently puberulent on midrib below, the midrib above gradually narrowing from base, sharply raised, 0.1–0.35 mm. wide at midpoint, below raised, angled to striate, the venation on both surfaces apparent, raised, (5 or) 6 to 11 (or 12) veins/5 mm., angle of divergence 70–80°. Inflorescences axillary or terminating short axillary shoots, with (1 to) 3 to 9 flowers, sometimes flabellate, unbranched, the axis (0.1–)0.35–2.7(–5) cm. long, sparsely to subdensely puberulent, lowest internode (0.1–)0.3–1.5(–3.4) cm. long; bracts elliptic, 1–8 mm. long, ± deciduous, or foliaceous, to 5.2 by 2.3 cm., subpersistent; pedicels 3–9 mm. long, sparsely puberulent. Flower (?)hermaphroditic; tepals 8 (to 12), the outer pair suborbicular, 3–4.5 by 3–4 mm., sometimes puberulent on back near base, the next pair broadly elliptic, 5.5–8 by 3.5–4.5 mm., the inner ones elliptic to obovate, 5.5–10 by 2–4.5 mm.; stamens 125 to 250, the filaments 1.5–4 mm. long, connate for up to 1.5 mm., the anthers suboblong to elliptic,

0.4–0.9 mm. long,  $\pm$  retuse at apex; ovary 1.2–1.8 mm. long, style 4.5–5.5 mm. long, stigma obscure. Fruit ellipsoid (rarely ovoid), 1.4–1.8 by 0.9–1.15 cm., minutely apiculate or not, drying pale brown, wrinkled; outer layer not detaching cleanly from stone, 0.4–1 mm. thick, compact; stone ellipsoid, 1.3–1.7 by 0.8–1 cm., rounded at apex, the walls ca. 0.1 mm. thick, smooth, (?)unmarked; spongy layer thin.

DISTRIBUTION. Southern China (Kwangtung, Kwangsi; reported also from Yunnan (Auct., Ic. Corm. Sin., *loc. cit.*)), Hong Kong, and northern Vietnam (MAP 50).

SELECTED SPECIMENS SEEN. **China:** KWANGTUNG: Pok Lor, *Fung Hom A-548* (NY); Yam na Shan (Yit Nga Shan), Mei (Kaying) Distr., *W. T. Tsang 21525* (A, K, NY, P); Ting Wu Shan, *W. Y. Chun 6406* (A, E, K, US, W); San-on Distr., Ng-Tung Shan, 940 m., *T. M. Tsui 230* (F, K, MO, NSW); Lofoushan, *Ying 1714* (SING). KWANGSI: Sehfangdarshan, S. Nanning, 762 m., *R. C. Ching 8086* (A, NY, US); Shap Man Taai Shan, near Ping Hoh village, SE. of Shang-sze, Kwangtung Border, *W. T. Tsang 22047* (A, BM, P); Hainan, Mochung Mt., Tingkap, Tingan, *S. P. Ko 52238* (NY), Yaichow, *H. Y. Liang 61994* (E, M, NY), Five Finger Mt., 500 m., *CCC 8495* (A, BM, C, E, G, K, MO, P), Dung Ka to Wen Fa Shi, *N. K. Chun & C. L. Tso 43684* (NY), Ka Chik Shan & vicinity, Ch'ang Kiang Distr., *S. K. Lau 1633* (A, BM, NY, P), Ng Chi Leng, Fan Yah, 914 m., *N. K. Chun & C. L. Tso 44133* (A, E, F, NY), Kan-en Distr., Chim Fung Ling, near San Mo Watt village, *S. K. Lau 3856* (A, P), Ngai Distr., Yeung Ling Shan, *S. K. Lau 86* (A, B, BM, E, G, K, MO, NY, P, US, W), Po Ting, 365 m., *F. C. How 71875* (A, BM). **Hong Kong:** Aberdeen, *Y. S. Lau 47* (A); Kowloon, Wong Keng Tsai, Shatin, *Y. W. Taam 2298* (G, NY, US); Wong Kum Cha, *Y. K. Chan 3043* (NY); Pic Victoria, *Bodinier 1450* (E, P); Ma On Shan, *S. Y. Hu 9329* (A); ravine leading to Pok-foo-lum, *Lamont 43* (BM); Kadoorie Farm, Kuan Yin Shan, *S. Y. Hu 12014* (A); Tai Mo Shan, *S. Y. Hu 11274* (A). **Vietnam:** Tam Dao, 850 m., *Petelot 4241* (A, BO, NY, P, US); Nin Thai, Muon Long, *Bon 3955* (P); Quombi, *Balansa 1504* (G, P); station experimental de Phu Tho, *Chevalier 41053* (P); Ha Coi, Tuai Wong Mo Shan, near Chuk Phai, *W. T. Tsang 29024* (A, BO, C, E, G, K, P, SING).



MAP 50. Distribution of *Calophyllum membranaceum* in Asia (circles, localized; squares, unlocalized).

**ECOLOGY.** Locally common, lowland or (usually) colline forest, sometimes in rocky places; 50–915 m. alt. Flowering April and May, rarely in March; (flower scented); fruiting October to December, rarely September or January (fruit yellow to orange—those reported as black seem to be immature).

**LOCAL USES.** Used in Yunnan to reduce the inflammation around bruises and to kill pain (Auct., Ic. Corm. Sin., *loc. cit.*)

*Calophyllum membranaceum* can be easily recognized, even when sterile, by its strongly angled twigs, its suboblong, thinly coriaceous lamina that often dries greenish and has prominent veins leaving the midrib at 70–80°, and its deeply concave petiole. The inflorescence is somewhat variable. There are sometimes fully developed leaves in the lower part of the inflorescence axis so that the inflorescence appears to be terminal. The asymmetrical, nonpeltate stigma of the flower and the thin outer and woody layers of the fruit are also distinctive. The epithet *membranaceum* ("membranaceous") was presumably suggested because of the texture and thinness of the dry leaf blades.

There is relatively little variation in flower and fruit, but specimens of *Calophyllum membranaceum* from Hong Kong frequently have more than eight tepals. In all other respects they agree with specimens from other parts of the range of the species.

*Calophyllum bonii* was based on specimens with very small inflorescences—this was the key character used by Gagnepain (*loc. cit.*) to separate it from the other species of *Calophyllum* growing in Indochina. However, as mentioned above, inflorescences in *C. membranaceum* are variable in appearance, and *C. bonii* has been reduced to synonymy under *C. membranaceum* without hesitation. *Bon 4136* is designated the lectotype of *C. bonii*; the original description was also based on *Balansa 1504*.

*Calophyllum tonkinense* was based on three numbers collected by the Abbé Bon (*Bon 3159, 3282, and 4301*) that are indistinguishable from other specimens assigned to *C. membranaceum*. *Calophyllum tonkinense* has been lectotypified on *Bon 4301*, a specimen with flowers.

176. *Calophyllum echinatum* P. F. Stevens, sp. nov.

FIGURE 45, c.

A speciebus aliis *Calophylli* in gemma terminali longa, pari superiore gemmarum axillarium conspicuo patentique, lamina plerumque saltem 9 cm. longa margine arcte undulata costa supra lamina elevata circumcincta venulis lateralibus 15 usque ad 22/5 mm., et fructu strato exteriori fibroso fibris putamine confluentibus, differt.

Tree to 26 meters tall, d.b.h. to 75 cm.; details of bark not known.

Twigs slightly to strongly flattened, 2.5–3 mm. across, 2-, 4-, or 6-angled, soon becoming rounded, drying yellowish, farinose-puberulent when young; axillary innovations lacking basal scars; internodes (1–)2–6.5(–10) cm. long; uppermost pair of axillary buds ± acute, 1.5–7 mm. long, spreading to suberect; terminal bud narrowly conical, (0.7–)0.9–1.7 cm. long, with brown, subcrustaceous indumentum (hairs, FIGURE 41, t, u), underdeveloped internode 3.5–9



mm. long. Petiole 1.7–2.4 cm. long, strongly concave above, convex below, drying blackish, glabrous; lamina ovate or elliptic to suboblong, (5.2–)9–13.5 by (2.2–)3.2–5.2 cm., acute to short-acuminate at apex, acute to cuneate at base, closely and strongly undulate and slightly recurved at margin, coriaceous, gray- to green-olivaceous above and sepia-olivaceous-sabelline below, subpersistently puberulent on midrib below, the midrib above abruptly narrowed near base, raised, surrounding lamina also raised, 0.3–0.55 mm. wide at midpoint, below strongly raised, angled, the venation subobscure on both surfaces (subapparent above), slightly raised, 15 to 22 veins/5 mm., angle of divergence 70–80°. Inflorescences from uppermost foliate axils, with ca. 11 flowers, the branches 3-flowered, to 1.3 cm. long, the axis 4–6 cm. long, puberulent, lowest internode 1–3.5 cm. long; bracts not known; pedicels ca. 2.8 cm. long, puberulent. Insect-damaged flowers only known; tepals 4, the outer pair broadly ovate, ca. 6 by 5 mm., puberulent on back, the inner pair obovate, ca. 9.5 by 6 mm.; stamens and ovary not known. Fruit ellipsoid, ca. 5.3 by 3 cm., obtuse at apex, drying vinaceous-brown, deeply and distantly wrinkled; outer layer not clearly distinguishable from stone, fibrous, large air spaces developing; stone ellipsoid, ca. 2.7 by 1.7 cm., rounded at apex, the walls to 0.8 mm. thick, in places only 0.1 mm. thick, not marked, rough, with branched, anastomosing fibers arising from stone; spongy layer (?) thin.

TYPE: Celebes, Malili, Oesoe, *Cel.* /II-407 coll. *Waturandang* (holotype, BO).

DISTRIBUTION. Known only from the Celebes (MAP 49).

ADDITIONAL SPECIMENS SEEN. **Celebes:** Malili, Oesoe, 50 m., *bb* 32596 (BO, L), 200 m., *Cel.* /II-215 (A, BO, L); Thawatta, 200 m., *Cel.* /II-407 coll. *Gonggrijp* (A, BO, L); Lingkomomo, Timampoe, 300 m., *bb* 8566 (BO).

ECOLOGY. Forest, 20–300 m. alt.

The fruits of *Cel.* /II-407 coll. *Gonggrijp* appear to be galled; they are flattened-ellipsoid structures ca. 6 by 2.3 cm. that are open on one side.

*Calophyllum echinatum* is a distinctive species that is easily recognizable, even when sterile. The terminal bud is rather long (usually over 9 mm.) and narrow, and the uppermost pair of axillary buds is conspicuous and spreading. The black-drying petiole contrasts strongly with the yellowish stem. The elliptic to oblong lamina is closely undulate at the margin, the midrib on the upper surface is surrounded by raised blade, and the venation is very fine and dense (15 to 22 veins/5 mm.). The ellipsoid fruit is large (ca. 5.3 cm. long), with the outer layer much disorganized by air spaces and containing fibers continuous with the stone; the stone is about 2.7 cm. long. The fibers arising from the stone give it a spiny appearance, hence the epithet *echinatum* ("prickly").

Although some specimens of *Calophyllum soulattri* from the Celebes (e.g., *Cel.* /III-63) have a midrib similar to that of *C. echinatum*, they do not otherwise approach that species. In *C. soulattri* the uppermost pair of axillary buds

is usually erect (rather than spreading), the lamina is thinner, the lowest internode of the inflorescence is shorter, the pedicels and outer tepals are nearly always glabrous, and the tepals are smaller. The fruit of *C. soulattri* is quite different from that of *C. echinatum*: it is about one-quarter the length and has a compact, slightly fibrous outer layer.

177. *Calophyllum exiticostatum* P. F. Stevens, sp. nov.      FIGURE 45, d-f.

A speciebus aliis *Calophylli* in lamina parva 2-5(-7.5) cm. longa basi plerumque rotundata venulis lateralibus densis et costa infra apicem evanescenti, petiolo brevi 1.5-4 mm. longo, et fructus circa 7 mm. longo strato exteriori forte proviso, differt.

Large tree 30-45 meters tall, d.b.h. to 140 cm.; trunk without buttresses; outer bark yellowish, with shallow, diamond-shaped fissures, the inner surface orange; under bark dark red; inner bark pale red; latex at first yellow, clear, becoming opaque.

Twigs slightly flattened, 1-1.5 mm. across, strongly 4-angled (with obscure horizontal lines at nodes), drying blackish brown, puberulo-tomentose when young; axillary innovations lacking basal scars; internodes 0.5-3 cm. long; uppermost pair of axillary buds rounded, ca. 0.8 mm. long, erect; terminal bud plump to conical, 2.3-3 mm. long, with brown, subadpressed indumentum (hairs, FIGURE 46, e-g), underdeveloped internode absent. Petiole 1.5-4 mm. long, broadly concave above and convex below, subpersistently puberulent; lamina ovate to elliptic, 2-5(-7.5) by 0.9-2.6(-3.1) cm., rounded (rarely subretuse or subacute) at apex, broadly to narrowly rounded or cuneate at base, not undulate or slightly so and not recurved at margin, coriaceous, drying umber to fulvous above and cinnamon to sabelline below, subpersistently puberulent on midrib below, the midrib above gradually narrowed from or abruptly narrowed at base, flat to slightly raised, subsulcate at base, 0.05-0.2 mm. wide at midpoint, below  $\pm$  level or slightly raised, striate, generally disappearing 2-3 mm. below apex, the venation obscure to subapparent on both surfaces, slightly raised, 14 to 23 veins/5 mm., angle of divergence 40-60(-70)°. Inflorescences axillary, with 5 to 7 flowers, unbranched, the axis 4-10 mm. long, densely pubescent, especially near base, lowest internode ca. 2 mm. long; bracts not known; pedicels 3.5-6.5 mm. long, pubescent. Flower (?) hermaphroditic; tepals 4, the outer pair ovate, 4-5 by ca. 2 mm., puberulent on back, the inner pair  $\pm$  elliptic, 3.5-4.5 by 1.5-3 mm., with strip of indumentum down back; stamens 40 to 50, the filaments to 2.5 mm. long, the anthers oblong, 1-1.2 mm. long, rounded to shallowly retuse at apex; ovary ca. 1.5 mm. long, the style ca. 2.2 mm. long, the stigma peltate, ca. 0.6 mm. across. Fruit spherical, ca. 7 by 7 mm., rounded or minutely apiculate at apex, drying vinaceous-brown, smooth; outer layer not detaching cleanly from stone, ca. 0.8 mm. thick, with large air spaces developing beneath skin; stone spherical, ca. 5.5 by 5.5 mm., rounded at apex, the walls ca. 0.15 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Sumatra, Palembang, Lematang Ilir, Semangoes Reserve, 75 m., 8 May 1940, *bb 31756* coll. *Buwalda* (holotype, A; isotypes, BO, K, L, NY, SING).

DISTRIBUTION. Southern Sumatra and northern Borneo (MAP 49).

ADDITIONAL SPECIMENS SEEN. **Sumatra.** SELATAN: Lematang Oeloe, 110 m., *Grashoff* 161 (BO), 150 m., *Grashoff* 224 (BO, L); Pasemahlanden, Djangkar, 900 m., *bb* 8118 (BO); Afd. Redjang, bij desa Loeboek binjai, Rimba Ketjau, *bb* 2299 (BO, L). **BARAT:** [Barisan], Manindjau, Silajang, 500 m., *bb* 3971 (BO). **Borneo.** SABAH. Ranau: Poring turn-off, Kota Kinabalu-Sandakan road, 640 m., *Stevens et al.* 559 (A), 563 (A).

ECOLOGY. Colline rainforest, 75-900 m. alt. Flowering in March; fruiting in May.

GERMINATION AND YOUNG PLANT. The young plants grow erect, and the terminal bud is functional. The leaf blades are up to 11.5 by 3 cm.

*Calophyllum exiticostatum* is an easily distinguishable species. It has strongly four-angled twigs, a short terminal bud, and small, very densely veined leaves that are usually rounded at the base. The inflorescence axis is more or less puberulent, the flowers have four tepals, and the spherical, smooth fruit has large air spaces in the outer layer. The midrib, which disappears just below the apex of the blade, suggested the epithet *exiticostatum* ("going-out-midrib").

The closest relative of *Calophyllum exiticostatum* may be *C. calaba*, although the latter species has somewhat larger leaf blades with usually less steeply ascending venation and a midrib that continues to the apex of the blade. In addition, the fruit of *C. calaba* lacks the strong epicarp of *C. exiticostatum*. *Calophyllum brachyphyllum*, from the Philippine Islands, also has small leaf blades with dense venation, but this species has a much more coriaceous blade that is retuse at the apex, and larger fruits with both the outer layer and the stone thicker.

Despite the 1500 km. distance separating the localities of *Calophyllum exiticostatum* in Sabah (near Mt. Kinabalu) and Sumatra, the Bornean specimens are vegetatively similar to the Sumatran ones. The only differences seem to be that in the Sumatran specimens the midrib is a little more prominent, the lamina is a little larger (measurements in parentheses in the description above), and the horizontal lines at the nodes are more obvious (cf. also *C. gracilipes*). However, material in flower and fruit is needed to confirm this similarity; the description of the bark is taken from Bornean material.

#### 178. *Calophyllum* sp.

Tree ca. 8 meters tall, d.b.h. to 6 cm.; trunk and bark unknown.

Twigs flattened, 3-3.5 mm. across, 4-angled, drying dark brown, tomentose when young; axillary innovations lacking basal scars; internodes 2.5-4 cm. long; uppermost pair of axillary buds subrounded, ca. 2 mm. long, erect; terminal bud bluntly conical, ca. 4 mm. long, tomentose, underdeveloped internode absent. Petiole 2.8-3.3 cm. long, rather narrowly concave above, convex below, glabrous when mature; lamina ovate-oblong, 16.5-18 by 6-6.5 cm., short-acuminate at apex, rounded to acute at base, distantly undulate and slightly recurved at margin, coriaceous, drying umber above and fulvous-

umber below, with sparse hairs persisting on midrib below, the midrib above gradually narrowing from base, raised, 0.3–0.4 mm. wide at midpoint, below raised, substrate to subangled, the venation above apparent, below subobscure, raised, latex canals impressed below, 5 or 6 veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils, with ca. 5 flowers, unbranched, the axis 3–3.5 cm. long, puberulo-tomentose, lowest internode 0.6–1.1 cm. long; bracts unknown; pedicels 0.5–1.4 cm. long, puberulo-tomentose. Flower (?) hermaphroditic; tepals ca. 12, the outer pair subovate, ca. 1.5 by 1 cm., puberulent at base on back, the next pair suborbicular, ca. 1.3 by 1.3 cm., the inner ones oblong-obovate, 1.1–1.6 by 0.4–1 cm.; stamens ca. 410, the filaments to 8 mm. long, the anthers oblong, 1.2–1.6 mm. long, retuse at apex; ovary ca. 3 mm. long, the style ca. (?) 6 mm. long, the stigma peltate, ca. 1.6 mm. across, 2-radiate. Fruit unknown.

DISTRIBUTION. Philippine Islands (MAP 49).

SPECIMEN SEEN. **Philippine Islands.** LUZON. Tayabas: Malbog, 100 m., *FB 30772* (NY).

ECOLOGY. Forest, ca. 100 m. alt. Flowering in February; flower scented.

*Calophyllum* sp. 178 can be recognized by its short, bluntly conical terminal bud, its long petioles, its relatively large, ovate-oblong leaf blades with the venation clearly raised on the upper surface but obscure and barely raised (with latex canals impressed) on the lower, and its few-flowered axillary inflorescences. The flowers are large and have about twelve tepals.

It is premature to describe this taxon in the absence of fruits, but its conical, rather short terminal bud and its distant venation suggest that it is not related to the variable *Calophyllum blancoi*.

179. *Calophyllum macrophyllum* Scheffer, *Natuurk. Tijdschr. Nederl.-Indië*, VII. 2: 405. 1873; Vesque in C. DC. *Monogr. Phanerog.* 8: 609. 1893; *Lauterb. Bot. Jahrb.* 58: 14. 1922; T. C. Whitmore, *Gard. Bull. Singapore* 22: 12. 1967; P. F. Stevens, *Austral. Jour. Bot.* 22: 377. 1974. TYPE: Gebeh [Irian Jaya], *Teysmann, HB 7574* (holotype, BO; isotypes, C, K, L, MEL).

(?) Tree; details of trunk and bark unknown.

Twigs slightly flattened, 5–7 mm. across, strongly 4-angled to -alate, drying brown, glabrous at maturity; terminal bud  $\pm$  conical, ca. 5 mm. long, with brownish indumentum, hairs adaxially curved and very papillate; other details of twigs and buds unknown. Petiole 1.3–1.7 cm. long, shallowly concave above, angled below, glabrous at maturity; lamina elliptic to suboblong, 32–45 by 9–11 cm., acute at apex, cuneate at base, barely undulate and slightly recurved at margin, coriaceous, drying olivaceous above and fulvous-umber below, glabrous at maturity, the midrib above rather quickly narrowed at base, raised, 0.3–0.4 mm. wide at midpoint, below strongly raised, angled, the venation obscure above, apparent below, raised, with 3 to 5 veins/5 mm., angle of divergence ca. 80°. Inflorescence, flower, and fruit not known.

DISTRIBUTION. Gebeh Island (MAP 45); known only from the type collection.

The very large leaf blades with distant venation and the relatively small terminal bud allow *Calophyllum macrophyllum* to be recognized readily, but it is still known only from the rather fragmentary sterile collection on which the original description was based. The epithet *macrophyllum* ("large leaf") was presumably suggested because of the size of the leaves.

Although it seems unlikely that *Teysmann*, HB 7574 was taken from a sapling (Stevens, *loc. cit.*), the leaves would be large even for a young plant of *Calophyllum*. Fertile collections of *C. macrophyllum* would be of considerable interest; it is possible that it is related to *C. celebicum*.

#### NOMINA NON SATIS COGNITA

*Calophyllum cerasiforme* Teijsm. & Binn. ex Koord.-Schum. Syst. Verzeich. 2: 7. 1910. *Nomen*.

I cannot identify the specimen on which this name is based (*Koorders* 10623, from Sumatra); see also *Calophyllum* sp. 9.

*Calophyllum kunstleri* King var. *longifolium* Boerl. Catal. Pl. Phanerog. Horto Bot. Bogor 2: 80. 1901; Koord.-Schum. Syst. Verzeich. 2: 58. 1910. *Nomen*.

I have been able to identify neither the specimens cited in the references above, nor that listed under *Calophyllum kunstleri* in *Koorders-Schumacher* (*loc. cit.*). The "*Calophyllum kunstleri*" currently grown at Bogor (plant VI C 237) is *C. calaba* var. *bracteatum*.

*Calophyllum lonchophyllum* O. Schwarz, Repert. Sp. Nov. 24: 89. 1927. TYPE: Australia, Northern Territory, Finniso River district, *Bleeser* A22.

#### Tree.

Branches terete, branchlets plicate-sulcate; buds with fuscous, adpressed, pubescent indumentum, the hairs contorted, unbranched. Petiole 5–9 mm. long; lamina long-lanceolate, 12–19 by 1.4–3.5 cm., long-acuminate at apex, narrowly acute (?and/or cuneate) at base, coriaceous, glabrous, the midrib above immersed-prominulous, below carinate, yellowish, the lateral nerves spreading horizontally, very close.

The description above is based on the protolog. *Bleeser* A22, from which Schwarz took his description, was apparently a sterile specimen and has since been destroyed, having been held in Berlin. It is impossible to tell to what species the name *Calophyllum lonchophyllum* should be referred.

*Calophyllum minus* Ridley, Dispersal Pl. World, 207. 1930. *Nomen*.

As noted by Ridley (*loc. cit.*), Guppy found that fruits of this species, which grew inland in the Solomon Islands, float. The name is not mentioned in Guppy, Solomon Is. 1867.

*Calophyllum vanoverberghii* Merr. Philip. Jour. Sci. C. **9**: 454. 1915. TYPE: Philippine Islands, Luzon, subprovince of Bontoc, Bauco, ca. 1700 m., 12 Sept. 1918, *Vanoverbergh 1466* (PNH, destroyed).

Small tree ca. 3 meters tall.

Twigs drying grayish or olivaceous, sometimes slightly pubescent at tips; terminal bud ferrugineous-pubescent. Petiole ca. 1 cm. long, slightly pubescent at first, otherwise glabrous; lamina oblong, 5–8 by 2–3 cm., obtuse at apex, acute or slightly decurrent at base, thickly coriaceous, drying concolorous, nitid, glabrous when mature, nerves very close. Inflorescences axillary and terminating short lateral branchlets, branched, with 3 short branchlets, often also with additional flowers, the axis 1.5–2.5 cm. long, the lowest internode very short, usually somewhat ferrugineous-pubescent; pedicels 5–10 mm. long. Tepals 4, the outer pair broadly ovate, ca. 6 mm. long, sometimes glabrous, concave, the inner pair narrowly obovate, ca. 8 mm. long; stamens indefinite, the filaments to 3.5 mm. long, the anthers narrowly obovoid or oblong-obovoid, 1.5–2 mm. long; ovary glabrous, style ca. 2 mm. long. Fruit unknown.

Although Merrill's description of the inflorescence of *Calophyllum vanoverberghii* (translated above) reads somewhat like that of *C. soulattri*, a species which also has four-tepaled flowers, *C. soulattri* never has an oblong, very coriaceous lamina that dries concolorous and nitid. *BS 75484* (from Catanduanes, Luzon) may belong to *C. vanoverberghii*; the outer layer of the fruit of this specimen is not compact, unlike that of *C. soulattri*, although in inflorescence the two are similar.

*Calophyllum* sp. Merr. Jour. Arnold Arb. **19**: 355. 1938.

Merrill (*loc. cit.*) noted that *Rheedia umbellata* Houtt. (Nat. Hist. II. **3**: 3. 1774) was a new name for *R. javanica* Burman f. (Fl. Indica, 118. 1768) and that it might be a species of *Calophyllum*. I have not been able to identify *R. javanica* more precisely.

#### NOMINA EXCLUDENDA

*Calophyllum acuminatum* Lam. Encycl. Méth. Bot. **1**: 553. 1785. TYPE: sine loco, anon. (lectotype, ♀).

The specimen that Lamarck had on hand consists of a fruiting element, referable to *Calophyllum tacamahaca*, and a leafy element, referable to a species of *Garcinia*. The name *C. acuminatum* was lectotyped on this latter element (see P. F. Stevens, Jour. Arnold Arb. **57**: 181. 1976).

*Calophyllum akara* Burman f. Fl. Indica, 121. 1768. TYPE: based on Rheede, Hortus Malabar. **5**: 15. t. 8. 1685 (*Akara patsjoti*).

According to Merrill (Philip. Jour. Sci. **19**: 366. 1921), this is properly called *Tetracera akara* (Burman f.) Merr. (Dilleniaceae).

*Calophyllum angustifolium* Roxb. Fl. Indica, ed. 2 (W. Carey, ed.), **2**: 608. 1832, Hortus Bengal. 41. 1814, *nomen*; Choisy, Descr. Guttif. Inde,

43. 1849, Mém. Soc. Phys. Hist. Nat. Genève **12**: 423. 1851; Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 293. 1862; T. Anderson in Hooker f. Fl. Brit. India **1**: 276. 1874; Vesque in C. DC. Monogr. Phanerog. **8**: 609. 1893. TYPE: Malaya, Penang, *Roxburgh s.n.* (lectotype, BM, *quoad Garcinia*).

The protolog to this species reads "Twigs cylindric. Leaves short-petioled, lanceolate, with lengthened, somewhat obtuse points, lucid, finely veined. Flowers in axillary fascicles; pedicels with a cyatheiform apex. . . ." There are two elements on a sheet presumably of the type at the British Museum: a vegetative shoot of a species of *Calophyllum* with "*Calophyllum angustifolium*" written on one of the leaves, and a shoot of a species of *Garcinia* with pistillate flowers just past anthesis. The only part of the original description clearly referable to *Calophyllum* is the mention of the leaves being lucid and finely veined, although Roxburgh also says that "peon" (poon) spars for the masts of ships come from this species—probably also referring to this element. The mention of the leaves having somewhat obtuse points best fits the shoot of *Garcinia*, as does the description of the inflorescence and the pedicel.

Since most of the protolog of *Calophyllum angustifolium* seems to be based on the shoot of *Garcinia*, it is reasonable to lectotypify the name on this element. I do not know to which species of *Garcinia* this shoot belongs; the epithet *angustifolia* is already occupied in *Garcinia* (*G. angustifolia* A. C. Smith, from New Guinea). The shoot of *Calophyllum* is not complete enough for identification; the terminal bud is not properly developed.

*Calophyllum augia* Steudel, Nomencl. ed. 2. **1**: 260. 1840, *nomen illegitimum* for *Augia sinensis* Lour. Fl. Cochinch. **1**: 337. 1790, *ibid.* ed. Willd. **1**: 411. 1793.

Merrill (Trans. Am. Philos. Soc. n.s. **24**(2): 244. 1935) equated this name with *Rhus succedana* L. (Anacardiaceae). The only element in the original description that might refer to *Calophyllum* is the mention of the flower having 100 stamens.

"*Calophyllum chinense* Walp.? ex Seemann in Bonplandia"; T. Anderson in Hooker f. Fl. Brit. India **1**: 270. 1874. *Nomen*.

Anderson (*loc. cit.*) equated this name with *Ochrocarpus longifolius* (Wight) Benth. & Hooker f. (= *Mammea longifolia* (Wight) Planchon & Triana). I have been unable to find any other reference to *Calophyllum chinense* except that given by Anderson, but he may have meant to refer to *Calysaccion chinense* Walp. (see Seemann, Bonplandia **4**: 299. 1856). This name is not included in Kosterman's (1956, 1961) revisions of the Asiatic and Pacific species of *Mammea*, but from Seemann's discussion it seems to be a synonym of *Calysaccion longifolium* Wight (= *M. longifolia*).

*Calophyllum dubium* Steudel, Nomencl. ed. 2. **1**: 261. 1840. Based on *C. longifolium* Wall. Catal. 4851. 1831. *Nomen*.

See *Calophyllum longifolium*, below.

*Calophyllum excelsum* Zoll. & Moritz, Nat. Geneesk. Arch. Neerl. Indië 2: 582. 1845.

As Merrill (Jour. Arnold Arb. 26: 94. 1945) noted, this name is to be referred to *Ochrocarpus odoratus* (Raf.) Merr., properly called **Mammea odorata** (Raf.) Kosterm.

*Calophyllum hexapetalum* Hooker f. Trans. Linn. Soc. 23: 163. 1860. TYPE: [In ora septentrionale insulae] Borneo, *Low s.n.* (holotype, K).

This is certainly a species of *Mesua*, but was not included by Kostermans (1969) in his list of new combinations in the genus.

*Calophyllum longifolium* Wall. Catal. 4851. 1831. *Nomen*.

Wight took up Wallich's epithet when he described *Calysaccion longifolium* Wight. This is correctly to be called **Mammea longifolia**.

*Calophyllum nagassarium* Burman f. Fl. Indica, 121. 1768.

This name has usually been referred to *Mesua ferrea* L. (Steudel, Nomencl. ed. 2. 1: 260. 1840); however, type material of *M. ferrea* apparently belongs to the species hitherto called *M. thwaitesii* (Kostermans, 1976). The species of *Mesua* commonly cultivated must be called **Mesua nagassarium** (Burman f.) Kosterm. Kostermans (*loc. cit.*) typified *C. nagassarium* on Rumphius, Herb. Amboin. 7: pl. 2. 1750. However, Burman may well have received material of *C. nagassarium*, since he stated "habitat in Amboina & Java, unde anno 1759. missa." There are two sheets of *C. nagassarium* originally in Burman's herbarium that are now in Geneva.

*Calophyllum neurophyllum* Schlechter, Bot. Jahrb. 39: 193. 1906. TYPE: New Caledonia, Hügeln bei Noumea, 20 m., Oct. 1902, *Schlechter 15091* (isotypes, G, P).

This is correctly called **Mammea neurophylla** (Schlechter) Kosterm.

*Calophyllum pustulatum* Ridley, Kew Bull. 1938: 118. 1938; Masamune, Enum. Phanerog. Born. 476. 1942. TYPE: Sarawak, near Kuching, 23 Jan. 1893, *Haviland 2117* (holotype, K; isotype, L).

This name is to be referred to *Mesua*, but it is not included in that genus by Kostermans (1969).

*Calophyllum touriga* C. T. White & Francis, Proc. Roy. Soc. Queensland 35: 63. 1923. TYPE: Australia, Queensland, Gourka pocket, Atherton Tableland, Jan. 1923, *Merriotsy s.n.* (lectotype, BRI, n.v.; see L. S. Smith, Proc. Roy. Soc. Queensland 68: 48. 1957).

This species is correctly called **Mammea touriga** (C. T. White & Francis) L. S. Smith.



*Calophyllum vidalii* F. Villar in Ceron, Catal. Pl. Herb. Manila, 229. plate. 1892. TYPE: Philippine Islands, Luzon, Camarines Sur Province, Mt. Isarog, [March 1886], *Vidal 2134* (isotype, A).

This species is correctly called *Schuurmansia vidalii* (F. Villar) Merr., a member of the Ochnaceae. In the original publication of *Calophyllum vidalii*, the name "*C. cuneatum* Vidal" is mentioned in synonymy; the latter is invalid.

#### LITERATURE CITED

- AL-JEBOURY, F. S., & H. D. LOCKSLEY. 1971. Xanthonenes in the heartwood of *Calophyllum inophyllum*—a geographical survey. *Phytochem.* **10**: 603–606.
- ALSTON, A. H. G. 1931. Handbook of the flora of Ceylon. Suppl. Vol. VI. vi + 350 pp. Dulau, London.
- ANDERSON, J. A. R., & J. MULLER. 1975. Palynological study of a Holocene peat and a Miocene coal deposit from N.W. Borneo. *Rev. Palaeobot. Palynol.* **19**: 291–351.
- ANDERSON, T. 1874. Guttiferae. Pp. 209–464 in J. D. HOOKER, Flora of British India. Vol. 1(2). L. Reeve, London.
- ANTHONY, M. 1974. Contributions to the knowledge of cecidia of Singapore. *Gard. Bull. Singapore* **27**: 17–65.
- ASHTON, P. S. 1964. Ecological studies in the mixed dipterocarp forests of Brunei State. *Oxford Forestry Mem.* **25**: 1–75.
- . 1977. A contribution of rain forest research to evolutionary theory. *Ann. Missouri Bot. Gard.* **64**: 694–705.
- . 1978. Flora Malesiana praecursores. Dipterocarpaceae. *Gard. Bull. Singapore* **31**: 5–48.
- & M. ASHTON, eds., 1972. The Quaternary era in Malesia. 122 pp. Trans. 2nd Aberdeen-Hull Symp. Males. Ecol. Univs. Hull & Aberdeen.
- BALGOOY, M. M. J. VAN. 1960. Preliminary plant geographical analysis of the Pacific. *Blumea* **10**: 385–430.
- . 1976. Phytogeography. Pp. 1–22 in K. PAUMANS, ed., New Guinea vegetation. Elsevier, New York.
- BARETTA-KUIPERS, T. 1976. Comparative wood anatomy of Bonnetiaceae, Theaceae and Guttiferae. *Leiden Bot. Ser.* **3**: 76–101.
- BEARD, J. S. 1976. The monsoon forests of the Admiralty Gulf, Western Australia. *Vegetatio* **3**: 177–192.
- BENTHAM, G. 1863. *Flora Australiensis*. Vol. 1. 20 + xl + 508 pp. Lovell Reeve, London.
- . 1876. On the recent progress and present state of systematic botany. *Rep. Brit. Assoc. Adv. Sci.* **1874**: 27–54.
- BERRY, E. W. 1925. The Tertiary flora of the island of Trinidad. *B. W. I. Johns Hopkins Univ. Stud. Geol.* **6**: 71–161.
- BEVERIDGE, A. E. 1975. Kauri forests in the New Hebrides. *Philos. Trans. Roy. Soc. London, B.* **272**: 369–384.
- BHANU, S., & F. SCHEINMANN. 1975. Xanthonenes from the heartwood of *Calophyllum ramiflorum*. *Phytochem.* **14**: 298, 299.
- BHATTACHARYYA, B. 1967. Tertiary plant fossils from Cherrapunji and Laitryngew in Khasi and Jaintia Hills, Assam. *Quart. Jour. Geol. Mining Metal. Soc. India* **39**: 131–134.

- BRANDZA, G. 1909. Recherches anatomiques sur la germination des Hypéricacées et des Guttifères. *Ann. Sci. Nat. Bot.* IX. 8: 221-300.
- BRUNIG, E. F. 1974. Ecological studies in the kerangas forests of Sarawak and Brunei. xiv + 237 pp. Borneo Lit. Bur., Sarawak Forest Dept.
- BURGER, D. 1972. Seedlings of some tropical trees and shrubs mainly of South East Asia. 399 pp. Center for Agr. Publ. Doc., Wageningen.
- BURGESS, P. F. 1966. Timbers of Sabah. Sabah Forest Rec. 6. xviii + 501 pp. Forest Dept., Sabah, Malaysia.
- CAMBESSÈDES, J. 1828. Mémoire sur les familles des Ternstroemiacees et des Guttifères. *Mém. Mus. Hist. Nat. Paris* 16: 369-429.
- CARPENTER, I., H. D. LOCKSLEY, & F. SCHEINMANN. 1969. Xanthones in higher plants: biogenetic proposals and a chemotaxonomic survey. *Phytochem.* 8: 2013-2026.
- CHIVERS, D. C. 1974. Siamang in Malaya. *Contr. Primatol.* 4: 1-335.
- CHOISY, J. D. 1823. Mémoire sur un nouveau genre des Guttifères et sur l'arrangement méthodique de cette famille. *Mém. Soc. Hist. Nat. Paris* 1: 210-232.
- . 1824. Guttiferae. Pp. 557-564 in A. P. DE CANDOLLE, *Prodromus systematis vegetabilium*. Vol. 1. Treuttel & Würtz, Paris.
- . 1849. Description des Guttifères de l'Inde. 60 pp. + 5 pls. Thury, Geneva.
- . 1851. Description des Guttifères de l'Inde. (Reprint.) *Mém. Soc. Phys. Hist. Nat. Genève* 12: 381-440.
- CHOWDHURY, K. A., & S. S. GHOSH. 1958. Indian woods. Vol. 1. liii + 304 pp. + 30 pls. Manager Publ., Delhi.
- CLARKE, C. B. 1894. Review of Monographiae Phanerogamarum, A. et C. de Candolle. 1894. Vol. VIII. Guttiferae. *Jour. Bot.* 32: 116-120.
- CORNER, E. J. H. 1976. The seeds of dicotyledons. Vol. 1. ix + 311 pp. Vol. 2. vi + 522 pp. University Press, Cambridge, England.
- CROMBIE, L., D. E. GAMES, N. J. HASKIN, & G. F. REED. 1972. Extractives of *Mammea americana* L. Part IV. Identification of new 7, 8-annulated relatives of the coumarins Mammea A/AA, A/AB, B/AA and B/AB, and new members of the 6-acyl family B/AA, B/AB and B/AC. *Jour. Chem. Soc. Perkins Trans. I.* 1972: 2248-2252.
- CRONQUIST, A. 1978. Once again, what is a species? Pp. 3-20 in J. A. ROMBERGER, ed., *Biosystematics in agriculture*. Wiley, New York.
- CULLEN, J. 1968. Botanical problems in numerical taxonomy. Pp. 175-183 in V. H. HEYWOOD, ed., *Modern methods in plant taxonomy*. Academic Press, New York.
- D'ARCY, W. G., & R. C. KEATING. 1979. Anatomical support for the taxonomy of *Calophyllum* (Guttiferae) in Panama. *Ann. Missouri Bot. Gard.* 66: 557-571.
- DARLINGTON, C. D., & A. P. WYLIE. 1955. Chromosome atlas of flowering plants. ed. 2. xix + 519 pp. George, Allen & Unwin, London.
- DARWIN, C. 1859. On the origin of species by means of natural selection. ix + 502 pp. Murray, London.
- DAVIS, P. H., & V. H. HEYWOOD. 1963. Principles of angiosperm taxonomy. xi + 556 pp. Oliver & Boyd, Edinburgh.
- DEJARDIN, J., J. L. GUILLAMET, & G. MANGENOT. 1973. Contribution à la connaissance de l'élément non endémique de la flore malgache (végétaux

- vasculaires). *Candollea* **28**: 325-391.
- DESCH, H. E. 1941. Manual of Malayan timbers. (Malayan Forest Rec. 15.) Vol. 1. vi + 328 pp. Caxton's Press, Kuala Lumpur.
- DOCTERS VAN LEEUWEN-REUNVAAN, J., & W. M. DOCTERS VAN LEEUWEN. 1926. The zoocecidia of the Netherlands East Indies. 601 pp. 's Lands Plantentuin, Buitenzorg.
- & ———. 1941. The zoocecidia of the Netherlands East Indies. Supplement I. *Nederl. Kruidk. Arch.* **51**: 122-251.
- ENGLER, A. 1925. Guttiferae. Pp. 154-237 in A. ENGLER & K. PRANTL, Die natürlichen Pflanzenfamilien. ed. 2. Vol. 21. Engelmann, Leipzig.
- ERDTMAN, G. 1971. Pollen morphology and plant taxonomy. Angiosperms. xii + 553 pp. Hafner, New York.
- ESTABROOK, G. F. 1977. Does common equal primitive? *Syst. Bot.* **2**: 36-42.
- FEDOROV, A. A. 1966. The structure of the rain forest and speciation in the humid tropics. *Jour. Ecol.* **54**: 1-11.
- . 1977. On speciation in the humid tropics: some new data. *Gard. Bull. Singapore* **29**: 127-136.
- FUNDTIER, J. M., & J. H. WISSE. 1977. 40 belangrijke houtsoorten uit Indonesisch Nieuw Guinea (Irian Jaya) met de anatomische en technische kenmerken. *Meded. Landb. Wageningen* **77-9**: 1-223.
- GAGNEPAIN, F. 1943. Guttifères. Pp. 237-264 in F. HUMBERT, ed., *Supplément à la flore générale de l'Indo-Chine*. Vol. 1(3). Mus. Nat. Hist. Nat., Paris.
- GAMBLE, J. S. 1881. A manual of Indian timbers. xxx + 522 pp. Govt. India, Calcutta.
- GAUTIER, J., G. KUNESCH, & J. POLONSKY. 1972. Structure of calophynic acid, a novel constituent of *Calophyllum inophyllum*. *Tetrahedron Letters* **1972**: 2715-2718.
- GIVNISH, T. J. 1978. On the adaptive significance of compound leaves with particular reference to tropical trees. Pp. 351-380 in P. B. TOMLINSON & M. H. ZIMMERMANN, eds., *Tropical trees as living systems*. Cambridge Univ. Press, Cambridge, England.
- GÖPPERT, H. R. 1854. Die Tertiärflora auf der Insel Java. 169 pp. + 14 tt. Mieling, s'Gravenhage.
- GRAAFF, N. A. VAN DER, & P. BAAS. 1974. Wood anatomical variation in relation to latitude and altitude. *Blumea* **22**: 101-121.
- GREENE, E. C., Jr. 1932. Santa Maria: a neotropical timber of the genus *Calophyllum*. *Trop. Woods* **30**: 9-16.
- GRIEG-SMITH, P., M. P. AUSTIN, & T. C. WHITMORE. 1967. The application of quantitative methods to vegetation survey. I. Association analysis and principal component ordination of rain forest. *Jour. Ecol.* **55**: 483-503.
- GRUBB, P. J. 1977. The maintenance of species richness in plant communities: the importance of the regeneration niche. *Biol. Rev.* **52**: 107-145.
- GUNESSEKARA, S. P., G. S. JAYATILAKE, S. S. SELLIAH, & M. U. S. SULTANBAWA. 1977. Chemical investigations of Ceylonese plants. Part 27. Extractives of *Calophyllum cuneifolium* Thw. and *Calophyllum soulattri* Burm. f. (Guttiferae). *Jour. Chem. Soc. Perkins Trans. I.* **1977**: 1505-1511.
- GUPPY, H. B. 1906. Observations of a naturalist in the Pacific between 1896 and 1899. Vol. 2. xxvi + 627 pp. Macmillan, London.
- HALLÉ, F., R. A. A. OLDEMAN, & P. B. TOMLINSON. 1978. Tropical trees and

- forests. xvii + 441 pp. Springer-Verlag, New York.
- HEGNAUER, R. 1966. Chemotaxonomie der Pflanzen. Band 4. 551 pp. Birkhäuser, Basel & Stuttgart.
- HENDERSON, M. R., & J. WYATT-SMITH. 1956. *Calophyllum* Linn. Gard. Bull. Singapore **15**: 284-375.
- HEYWOOD, V. H., ed., 1978. Flowering plants of the world. 335 pp. Mayflower Books, New York.
- HOLMGREN, P. K., & W. KEUKEN. 1974. Index herbariorum. Part I. The herbaria of the world. ed. 6. Reg. Veg. **92**: 1-397.
- HULL, D. 1978. A matter of individuality. Philos. Sci. **45**: 335-360.
- HUTCHINSON, J. 1969. Evolution and phylogeny of flowering plants. xxv + 717 pp. Academic Press, London & New York.
- JACOBS, M. 1968. Collections cited under abbreviations. Fl. Males. Bull. **22**: 1571-1578.
- JUDD, W. S. 1979. Generic relationships in the Andromedeae (Ericaceae). Jour. Arnold Arb. **60**: 477-503.
- KALKMAN, C. 1955. A plant-geographical analysis of the Lesser Sunda Islands. Acta Bot. Neerl. **4**: 200-225.
- KANEHIRA, R. 1924. Identification of Philippine woods by anatomical characters. 73 pp. Govt. Res. Inst., Taihoku, Formosa.
- KAUR, A., C. O. HA, K. JONG, V. E. SANDS, H. T. CHAN, E. SOEPADMO, & P. S. ASHTON. 1978. Apomixis may be widespread among trees of the climax rainforest. Nature **271**: 440-442.
- KAWAZU, K., H. OHIGASHI, & T. MITSUI. 1968. The piscidial constituents of *Calophyllum inophyllum* Linn. Tetrahedron Letters **1968**: 2383-2385.
- KENG, H. 1970. Size and affinities of the flora of the Malay Peninsula. Jour. Trop. Geogr. **31**: 43-56.
- KOSTERMANS, A. J. G. H. 1956. Additional notes on Mimosaceae. The genera *Mammea* L. and *Ochrocarpos* Thou. Djawa. Kehut. Indonesia Bag. Plan. Kehut. 1-15.
- . 1961. A monograph of the Asiatic and Pacific species of *Mammea* L. (Guttiferae). Pengum. Lemb. Pusat Penjel. Kehut. Indonesia **72**: 1-63.
- . 1969. *Kayea* Wall. and *Mesua* L. (Guttiferae). Reinwardtia **7**: 425-431.
- . 1976. Notes on the Clusiaceae of Sri Lanka and reduction of *Pentaphalangium* Warb. Ceylon Jour. Sci. Biol. Sci. **12**: 55-71.
- KRASSER, F. 1903. Konstantin von Ettingshausen's Studien über die fossile Flora von Ouricanga in Brasilien. Sitz-ber. Math.-Naturw. Akad. Wiss. Wien **112**: 852-860.
- KRAUSEL, R. 1929. Fossile Pflanzen aus den Tertiär von Süd-Sumatra. Verh. Geol.-Mijnb. Genoot. Voor. Nederl. Kol. Geol. Ser. **9**: 1-44.
- KUMAR, V., S. RAMACHANDRAN, & M. U. S. SULTANBAWA. 1976. Xanthones and triterpenoids from timber of *Calophyllum inophyllum*. Phytochem. **15**: 2016, 2017.
- LAKHANPAL, R. N., & N. AWASTHI. 1965. Fossil woods of *Calophyllum* from the Tertiary of South India. Palaeobot. **13**: 328-336.
- & M. N. BOSE. 1951. Some Tertiary leaves and fruits of the Guttiferae from Rajasthan. Jour. Indian Bot. Soc. **30**: 132-136.
- LECOMTE, H. 1922. Madagascar—les bois et la forêt d'Analamazaotra. vii + 189 pp. Challamel, Paris.
- . 1926. Les bois de l'Indochine. Vol. 1. iv + 311 pp. Atlas, 4 pp. + 68 pls. Agence Écon. Indochine, Paris.

- LEROY, J. F. 1975. Transpecific evolution: an hypothesis on the phylogenesis of Malagasy Guttiferae (summary). P. 97 in Abstr. Pap. XII Int. Bot. Congr. Izd-vo "Nauka," Leningrad.
- . 1977. Taxogénèse de la flore malgache: les genres *Mammea* L. et *Paramammea* Leroy, gen. nov. Compt. Rend. Acad. Sci. Paris, D. **284**: 1521–1524.
- LEVIN, D. A. 1979. The nature of plant species. *Science* **204**: 381–384.
- LEWIS, J. 1955. An aspect of judgment in taxonomy. *Taxon* **4**: 73–77.
- LUBBOCK, J. L. 1892. A contribution to our knowledge of seedlings. Vol. 1. viii + 608 pp. Appleton & Co., New York.
- MAGUIRE, B. 1976. Apomixis in the genus *Clusia* (Clusiaceae)—a preliminary report. *Taxon* **25**: 241–244.
- MAHESHWARI, J. K. 1960. Taxonomic studies on Indian Guttiferae. *Bull. Bot. Survey India* **2**: 139–148.
- MAURY, G. 1978. Dipterocarpacees du fruit à la plantule. Unpubl. Ph.D. Thesis, Univ. Paul Sabatier de Toulouse (Sciences).
- . 1979. Intérêt systématique et phylogénique des caractères juvéniles (germination, embryon mûr, plantules) chez les Dipterocarpacees. *Bull. Soc. Bot. France* **126**: 13–21.
- MAYR, E. 1968. Principles of systematic zoology. x + 428 pp. McGraw-Hill, New York.
- MERRILL, E. D. 1915. Genera and species erroneously credited to the Philippine flora. *Philip. Jour. Sci. C.* **10**: 171–194.
- . 1923. Distribution of the Dipterocarpaceae. *Philip. Jour. Sci.* **23**: 1–34.
- . 1926. An enumeration of Philippine flowering plants. Vol. 4. 515 pp. Bur. Printing, Manila.
- MIERS, J. 1855. Observations on the structure of the seeds and the peculiar form of the embryo in the Clusiaceae. *Trans. Linn. Soc. London* **21**: 243–258.
- MIQUEL, F. A. W. 1854. *Plantae Junghuhnianae*. Part 3. Pp. 271–394. Sythoff, Lugduni-Batavorum.
- . 1859. *Flora van Nederlandsch Indië*. Vol. 1(2, part 3). Pp. 353–512. Fleischer, Leipzig.
- . 1861. *Flora van Nederlandsch Indië*. Suppl. 1(3). Pp. 337–656. Fleischer, Leipzig.
- MOLL, J. W., & H. H. JANSSONIUS. 1906. *Micrographie des Holzes der auf Java vorkommenden Baumarten*. Vol. 1(1). 368 pp. Brill, Leiden.
- MULLER, J. 1972. Palynological evidence for change in geomorphology, climate, and vegetation in the Mio-Pliocene of Malesia. Pp. 6–16 in P. & M. ASHTON, eds., *The Quaternary era in Malesia*. *Trans. 2nd Aberdeen-Hull Symp. Males. Ecol. Univs. Hull & Aberdeen*.
- PAYNE, W. W. 1978. A glossary of plant hair terminology. *Brittonia* **30**: 239–255.
- PEARSON, R. S., & H. P. BROWN. 1932. *Commercial timbers of India*. 2 vols. xlv + 1150 pp. Govt. India, Calcutta.
- PENNINGTON, T. D., & J. SARUKHÁN. 1968. *Manual para la identificación de campo de los principales árboles tropicales de México*. v + 413 pp. Inst. Nac. Invest. Forest., Mexico.
- PERRIER DE LA BÂTHIE, H. 1948. Notes biogéographiques sur quelques plantes ayant contribué au peuplement de Madagascar. *Mém. Inst. Sci. Madagascar*, B. Bio. Vég. **1**: 113–132.
- . 1951. Guttiferae. In: H. HUMBERT, ed., *Flore de Madagascar et des*

- Comores. 136° Fam. 96 pp. Firmin-Didot, Paris.
- PIERRE, L. 1885. Flore forestière de la Cochinchine. Vol. 1(7). *Pls.* 97–112. Octave Doin, Paris.
- PUL, L. VAN DER. 1957. The dispersal of plants by bats (chiropterochory). *Acta Bot. Neerl.* 6: 291–315.
- PITARD, C.-J. 1910. Guttifères. Pp. 292–330 in M. H. LECOMTE, ed., Flore générale de l'Indo-Chine. Vol. 1(4). Masson et Cie., Paris.
- PLANCHON, J. E., & J. TRIANA. 1862a. Mémoire sur la famille des Guttifères [part]. *Ann. Sci. Nat. Bot.* IV. 15: 240–319.
- & ———. 1862b. Mémoire sur la famille des Guttifères [part]. *Ibid.* 16: 263–308.
- PRAKASH, U. 1966. Some fossil dicotyledonous woods from the Tertiary of eastern India. *Palaeobot.* 14: 223–235.
- . 1975. Phytogeographic evolution of Guttiferae and its bearing on the past climate. *Ibid.* 22: 63–75.
- & N. AWASTHI. 1971. Fossil woods from the Tertiary of eastern India II. *Palaeobot.* 18: 219–225.
- RAMEJI, M. V. 1967. Morphology and ontogeny of the foliar venation of *Calophyllum inophyllum* L. *Austral. Jour. Bot.* 15: 437–443.
- RAVEN, P. H. 1976. Systematics and plant population biology. *Syst. Bot.* 1: 284–316.
- & D. I. AXELROD. 1974. Angiosperm biogeography and past continental movement. *Ann. Missouri Bot. Gard.* 61: 539–673.
- RIDGWAY, R. 1912. Color standards and color nomenclature. iii + 43 pp. + 53 pls. Publ. by author, Washington, D. C.
- RIDLEY, H. N. 1915. The botany of Gunong Tahan, Pahang. *Jour. Fed. Malay States Mus.* 5: 127–202.
- . 1930. The dispersal of plants throughout the world. xx + 744 pp. L. Reeve, Ashford.
- ROBINS, R. J. 1976. The composition of the Jisani forest, Zanzibar. *Bot. Jour. Linn. Soc.* 72: 223–234.
- ROBSON, N. K. B. 1976. Guttiferae. Pp. 620–646 in H. L. LI *et al.*, eds., Flora of Taiwan. Vol. 2. Epoch, Taiwan.
- SAH, S. C. D., & R. K. KAR. 1974. Palynology of the Tertiary sediments of Palana, Rajasthan. *Palaeobot.* 321: 163–188.
- SCHOFIELD, E. K. 1968. Petiole anatomy of the Guttiferae and related families. *Mem. New York Bot. Gard.* 18: 1–55.
- SEETHARAN, Y. N., & S. A. J. POCKOCK. 1978. Taxonomy and pollen morphology of *Poeciloneuron* (Guttiferae). *Bull. Jard. Bot. Nat. Belg.* 48: 359–365.
- SHETLER, S., *et al.* 1973. A guide for contributions to Flora North America (FNA). Provis. ed. *Fl. N. Am. Rep.* 65: 1–28.
- SIMPSON, G. G. 1961. Principles of animal taxonomy. xii + 247 pp. Columbia Univ. Press, New York.
- SMITH, A. C. 1979. Flora Vitiensis nova. Vol. 1. vi + 495 pp. Pacific Trop. Bot. Gard., Hawaii.
- & S. P. DARWIN. 1974. Studies of Pacific Island plants, XXVIII. The Guttiferae of the Fijian region. *Jour. Arnold Arb.* 55: 215–263.
- SMITH, J. J. 1920. Plantae novae vel criticae ex herbario et horto Bogoriensis I. *Bull. Jard. Bot. Buitenzorg* 3: 390–410.
- SMITH, R. M. 1977. Additional notes on *Alpinia* sect. *Myriocrater*. *Notes Roy. Bot. Gard. Edinburgh* 35: 195–208.

- SPIRLET, M. L. 1966. Guttiferae. Pp. 1-107 in Contribution à la flore du Congo, du Rwanda et du Burundi. Inst. Natl. Étude Agr. Congo, Bruxelles.
- STAFLEU, F. A. 1967. Taxonomic literature. Reg. Veg. 52: 1-556.
- STANER, P. 1934. Les Guttifères de la flore du Congo Belge. Bull. Jard. Bot. Bruxelles 13: 61-164.
- STEARN, W. T. 1973. Botanical Latin. ed. 2. xiv + 566 pp. David & Charles, Newton Abbot.
- STEBBINS, G. L. 1950. Variation and evolution in plants. xix + 643 pp. Columbia Univ. Press, New York.
- . 1974. Flowering plants: evolution above the species level. xviii + 399 pp. Belknap Press, Cambridge, Massachusetts.
- STEENIS, C. G. G. J. VAN. 1949. General considerations. Pp. xiii-lxix in Flora Malesiana. Vol. 1(4)1-2. Noordhoff-Kolff, Djakarta.
- . 1950. The delimitation of Malaysia and its main plant geographical divisions. Pp. lxx-lxxv in *ibid.* Vol. 1(1).
- . 1957. Specific and intraspecific delimitation. Pp. clxvii-ccxxxiv in *ibid.* Vol. 1(5)3.
- . 1969. Plant speciation in Malesia, with special reference to the theory of non-adaptive saltatory evolution. Biol. Jour. Linn. Soc. 1: 97-133.
- . 1977. Autonomous evolution in plants. Gard. Bull. Singapore 29: 103-126.
- . 1978. *Patio ludens* and extinction of plants. Notes Roy. Bot. Gard. Edinburgh 36: 317-323.
- . 1979. Plant-geography of East Malesia. Bot. Jour. Linn. Soc. 79: 97-178.
- & A. F. SCHIPPERS-LAMERTSE. 1965. Concise plant geography. Pp. (1)-(72) in C. A. BACKER & R. C. BAKHUIZEN VAN DEN BRINK, JR., Flora of Java. Vol. 2. Noordhoff, Groningen.
- STEVENS, P. F. 1974a. A review of *Calophyllum* L. in Papuasias. Austral. Jour. Bot. 22: 349-411.
- . 1974b. *Mammea* L. and *Mesua* L. (Guttiferae) in Papuasias. *Ibid.* 413-423.
- . 1976. The Old World species of *Calophyllum* (Guttiferae). 1. The Mascarene species. Jour. Arnold Arb. 57: 167-184.
- . 1980a. The phytogeography and evolution of the Ericaceae of New Guinea. In: L. J. GRESSITT, ed., Biogeography and ecology of New Guinea. Monogr. Biol. Junk. (In press.)
- . 1980b. The correct names for the three elements in the protologue of *Calophyllum calaba* L. Pp. 168-176 in K. S. MANILAL, ed., Botany and history of *Hortus Malabaricus*. Oxford and IBH Publ. Co., New Delhi.
- SULTANBABA, M. U. S. 1973. Chemistry of the Guttiferae of Ceylon. Jour. Nat. Sci. Council Sri Lanka 1: 123-165.
- THWAITES, G. H. K. 1858. Enumeratio plantarum Zeylanicae (part 1). 80 pp. Dulau, London.
- TRIMEN, H. 1893. A handbook to the flora of Ceylon. Vol. 1. xvi + 327 pp. Dulau, London.
- TROUP, R. S. 1921. The silviculture of Indian trees. Vol. 1. lviii + 336 + iii pp. Clarendon Press, Oxford.
- VENKATASAN, N., & D. V. REGE. 1973. Nutritional evaluation of the seed protein of *Calophyllum inophyllum* and *Bassia latifolia*. Jour. Sci. Food

- Agr. **24**: 1317-1323.
- VESQUE, J. 1889. Epharmosis 2. Genitalia foliaque Clusiearum et Moronbearum. 29 pp. + 162 figs. de la Pierre, Vincennes.
- . 1893. Guttiferae. Pp. 1-669 in A. DE CANDOLLE, ed., *Monographiae Phanerogamarum*. Vol. 8. Masson, Paris.
- VESTAL, P. A. 1937. The significance of comparative anatomy in establishing the relationship of the Hypericaceae to the Guttiferae and their allies. *Philip. Jour. Sci.* **64**: 199-256.
- VINK, W. 1970. The Winteraceae of the Old World. I. *Pseudowintera* and *Drimys*—morphology and taxonomy. *Blumea* **18**: 225-354.
- VOGEL, E. F. DE. 1980. Seedlings of dicotyledons. 645 pp. Center for Agr. Publ. Doc., Wageningen.
- VOLKENS, G. 1912. Laubfall und Lauberneuerung in den Tropen. 142 pp. Borntraeger, Berlin.
- WHITE, F. 1962. Geographic variation and speciation in Africa with particular reference to *Diospyros*. *Syst. Assoc. Publ.* **4**: 71-103.
- . 1978. The taxonomy, ecology, and chorology of African Ebenaceae. I. The Guineo-Congolian species. *Bull. Jard. Bot. Natl. Belg.* **48**: 245-358.
- WHITMORE, T. C. 1969. A discussion on the Royal Society expedition to the British Solomon Islands Protectorate, 1965. Land flora. Geography of the flowering plants. *Phil. Trans. Roy. Soc. B.* **255**: 549-566.
- . 1973. Guttiferae. Pp. 162-236 in T. C. WHITMORE, ed., *Tree flora of Malaya*. Vol. 2. Longman Group, London.
- . 1974. Change with time and the role of cyclones in tropical rain forest on Kolombangara, Solomon Islands. *Commonw. Forestry Inst. Paper* **46**: 1-77.
- . 1975. *Tropical rain forests of the Far East*. xiii + 282 pp. Clarendon Press, Oxford.
- WIGHT, R. 1838. Illustrations of Indian botany (part 1). ii + 130 pp. Pharoad, Madras.
- . 1839. *Icones plantarum Indiae Orientalis*. Vol. 1(6-8). *Pls.* 101-161. Pharoad, Madras.
- WILDE, J. J. F. E. DE. 1956. A delimitation of *Mammea* L. *Acta Bot. Neerl.* **5**: 171-178.
- WILLDENOW, C. L. 1811. Über die Gattung *Calophyllum*. *Sitzungsber. Ges. Naturf. Fr. Berlin Mag.* **5**: 78-80.
- WILLIS, J. C. 1973. A dictionary of flowering plants and ferns. ed. 7. (H. K. AIRY SHAW, ed.) xxii + 1245 + lxvi pp. Cambridge Univ. Press, England.
- WRIGHT, H. 1904. The genus *Diospyros* in Ceylon: its morphology, anatomy, and taxonomy. *Ann. Roy. Bot. Gard. Peradeniya* **2**: 1-106, 133-210.
- YI-ZHEN, X. 1979. Pollen morphology of Guttiferae in China. (In Chinese, English summary.) *Acta Bot. Sinica* **21**: 36-41.

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#### ADDENDUM

Since this article went to press, an account of the genus *Calophyllum* in Sri Lanka has appeared (KOSTERMANS, A. G. J. H. 1980. Clusiaceae (Guttiferae). Pp. 72-110 in M. D. DASSANAYAKE, ed., A revised handbook to the flora of Ceylon. Vol. 1. Amerind, New Delhi). In this account, endosperm is said to be sometimes present as a thin, jellylike layer around the cotyledons; Thwaites (Jour. Bot. Kew Misc. 6: 72. 1854) noted that CP 2446 (*C. trapezifolium*) had a green embryo surrounded by abundant endosperm. These observations must be confirmed. Kostermans gives interesting information on the color and appearance of the young leaves. The species mentioned in his account are listed below; brief comments have been added so that Kostermans's account and the present one can be integrated.

1. *Calophyllum inophyllum*.
2. *Calophyllum tomentosum* (see also Thwaites, Enum. Pl. Zeyl. 51. 1858). Kostermans 24848 is considered to be a close match with material previously identified as *C. elatum*; reports of that species from Sri Lanka are included without hesitation in the synonymy under *C. tomentosum*.
3. *Calophyllum moonii*. The flowers are reported to have only four tepals.
4. *Calophyllum calaba*. Material assigned to *C. calaba* var. *worthingtonii* above is believed to represent the young stage of "typical" *C. calaba*.
5. *Calophyllum bracteatum*. The seedlings are noted as having very narrow, linear leaves; saplings 2 meters tall already show the leaf variation characteristic of this species.
6. *Calophyllum trapezifolium*. Galls are said not to occur on this species.
7. *Calophyllum zeylanicum*. This is included in *C. trapezifolium* in the present account.
8. *Calophyllum cuneifolium*.
9. *Calophyllum walkeri*.
10. *Calophyllum thwaitesii*. The conflicts with earlier descriptions of this species and its variation that Kostermans mentions are resolved by the description of *C. vergens*.
11. *Calophyllum cordato-oblongum*.

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